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6. AUTHOR(S)
Grady, Janet L.
Getsy, A. Jane

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Mount Aloysius College NTAI
7373 Admiral Peary Highway
Cresson, PA 16630

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Henry M. Jackson Foundation for the Advancement of Military Medicine
1401 Rockville Pike, Suite 600
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14. ABSTRACT
Deliverables associated with this project included development and testing of a Cyber Clinical Environment (CCE), encompassing leading-edge telehealth and information technologies for application in civilian and military training settings, outcome analysis of experiments to evaluate the impact of simulator-based education, and evaluation of the effectiveness of technology-delivered reinforcement methods following Diabetes Self-Management Education (DSME) programs. Studies conducted at Mt Aloysius College, Marquette University, and the USUHS Graduate School of Nursing showed that the use of telehealth tools to teach health assessment skills – even to relatively seasoned clinicians – is very useful. Within the GSN, results have led to similar instructional sessions during the 2nd year of the program. A number of simulation studies supported that the advantages of training with a high-fidelity mannequin are more significant for training complex skills rather than basic ones. Another study found that technology-delivered reinforcement following formal self-management education programs seems to require a more tailored and dynamically responsive process that may need to be offered daily rather than weekly or bimonthly. Using telehealth kiosks in community settings, exposure to and use of the telemedicine equipment by senior citizens increased the participants' feelings of self efficacy. The increase in self efficacy observed in this study parallels results observed in an earlier NTAI study of heart failure patients. Overall, this project was successful in outlining best practices in the use of telehealth technologies for training nurses and allied health professionals as well as for application in community-based health promotion and disease prevention programs.

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Objectives and accomplishments:

Development and testing/research of a Cyber Clinical Environment (CCE), encompassing leading-edge telehealth and information technologies for application in civilian and military training settings.

Develop/conduct/evaluate experiments to provide evidence for best practices in the use of simulation-based education for Nursing and Allied Health students.

Report outcome analysis of experiments to evaluate the impact of simulator-based education:

Evaluation report on the effectiveness of technology-delivered reinforcement methods following Diabetes Self-Management Education (DSME) programs.

ONR Award: N00014-04-1-0825

Henry M. Jackson Foundation

Nursing Telehealth Applications Initiative

Project Objectives and Accomplishments for Award Period: August 17, 2005 – August 16, 2006

Period of Performance: July 1, 2007 – December 31, 2009

Task 1) Deliverable: Development and testing/research of a Cyber Clinical Environment (CCE), encompassing leading-edge telehealth and information technologies for application in civilian and military training settings.

GOALS:

1) To develop and evaluate the use of a cyber clinical education environment that will allow students to use telehealth and information technologies to gain proficiency in practicing in a technology-enhanced healthcare system.

2) To provide opportunities for students to develop skills that will transfer from the simulated environment to the real world clinical practice arena.

BACKGROUND AND PURPOSE:

There is a critical need for the nursing profession to use, evaluate, and recommend best practices for the application of technology in practice and education. Various telehealth and information technologies offer the ability to manage health care data and improve access to health care information (1). Challenges for educators include not only providing technology-related experiences for students, but also strategically using technology to improve the educational process. These challenges are occurring at a time when nursing and allied health education programs are attempting to respond to increased enrollments, resulting from the current shortage of nurses and allied health professionals in numerous areas of our country. Many students are being turned away because there are too few nursing faculty and available clinical placement sites to provide the increasing number of students with the necessary clinical experiences (2, 3). While enrollments in all levels of nursing programs increased by 18% in 2005, the National League for Nursing estimates that 147,465 qualified student applications for Nursing Schools were turned away due to the shortage of faculty (4). An additional challenge exists in rural areas, where limited numbers of clinical practice areas exist, travel to and from these locations is problematic, and the range of specialty experiences for students may be lacking.

The timeliness of these issues in nursing education is emphasized by concomitant changes in societal demographics. The number of elderly patients with chronic diseases is increasing. Many of these individuals remain in the community, in either home or assisted-living settings, often with limited or insufficient access to healthcare services. To address these current and future needs, students must be provided with educational experiences that allow them to provide nursing care for this demographic group. However, placing students in community settings to gain these practice experiences is becoming increasingly difficult for a variety of reasons. This proposal addresses many of these issues by using telehealth technologies, both by providing students with these necessary educational experiences, while allowing hands-on experiences with remote assessment technologies that will be required to care for community-based patients or others located at a distance from the provider of services.

Telehealth has been defined as "the electronic transfer of health information from one location to another for purposes of health promotion, diagnosis, consultation, education, and/or therapy" (5). Telehealth encompasses videoconferencing, transmission of still images, e-health, remote monitoring, nursing call centers, use of electronic health records, and continuing health care professional education. Benefits of the use of telehealth approaches include increased access to care and more efficient use of resources (6, 7). The program of research in telehealth at Mount Aloysius College thus far has resulted in empirical support for the benefits of this mode of service delivery through testing and evaluation of the use of telehealth technologies to address decreasing resources in both nursing education and practice.

Because required training environments are often not available in the traditional format to schools in both urban and rural environments, this proposal seeks to address the problem by creating a simulated clinical education environment in which students learn using the latest telehealth and information technology tools, designed for the dual purpose of preparing a workforce capable of meeting the demands of the practice settings of the future and meeting the healthcare challenges by increasing access to care.

Since 2004, the Office of the National Coordinator for Health Information Technology has been guiding national technology initiatives in healthcare. The American Health Information Community, a federal advisory body, is charged with recommending strategies to move forward the development of Health Information Technology in the areas of consumer empowerment, chronic care, biosurveillance, and electronic health records. The synergistic relationship between telehealth and health information technology has been clearly articulated in a recent issue paper published by the American Telemedicine Association (ATA). In its paper entitled "Telemedicine, Telehealth, and Health Information Technology," the ATA describes the importance of overcoming resistance to the adoption of technology in healthcare. In the issue paper, ATA leaders stated, "accelerating the adoption of all forms of technology in healthcare is considered critical to improved outcomes, expanded access, and increased efficiency" (8). If this acceleration is to occur, nurses and other allied health professionals must be educated in the use of telehealth and health information technologies. This proposal seeks to outline best practices related to training nurses and allied health professionals to use telehealth technologies appropriately, including the use of health information for decision support ranging from individual patient-centered to community-centered.

PLAN:

The development and evaluation of a Cyber Clinical Environment (CCE) will occur in parallel on three campuses: Mount Aloysius College, a rural college in Cresson, PA; Marquette University, an urban university in Milwaukee, WI; and the Uniformed Services University of the Health Sciences in Bethesda, MD. The purpose of parallel development is threefold: 1) to expand the pool of patient encounters available as learning experiences for students; 2) to allow schools to share faculty expertise; and 3) to allow students from the three campuses to interact with each other to share their learning experiences.

Phase 1) Development (Months 1-4) – Identify learning objectives, case studies, equipment sets, learning outcomes, patient scenarios, and lesson plans. Develop a protocol for research and evaluation of the virtual clinical education environment and obtain IRB approval. It is envisioned that the simulated clinical education environment would include labs in which students would use remote assessment equipment housed at a central station to interview and examine professional patients located in another area of the lab, thus simulating the real-world situation of patients being located a distance from the healthcare provider. In the military setting, students would use telehealth devices developed for deployment operations to collect and transmit clinical data. Vignettes would be developed for use with professional patients, providing students the opportunity to develop skills in health assessment, remote monitoring, and critical thinking to support decision-making. In addition, relationships will be established with several assisted-living facilities to provide a venue for clinical practice in remote, community-based assessment and care of patients with chronic diseases such as diabetes and hypertension. Health information technology strategies could be incorporated into lab activities to provide practice with information management, use of electronic health record, and data-based decision support. Variations to address the needs of graduate education at the military site would include research to be conducted at the National Capitol Area Simulation (SIM) Center using professional patient actors and to increase the realism of the cases, the SIM center vignettes will be based on actual telehealth cases collected from clinicians serving in Operation Iraqi Freedom and Operation Enduring Freedom. Finally, telehealth technology will be used to simulate the real-world situation of patients geographically separated from the provider during Family Nurse Practitioner (FNP) and Certified Registered Nurse Anesthesia (CRNA) clinical rotations.

Phase 2) Implementation and pilot testing (Months 5-8) – Execute protocol and conduct preliminary evaluation of the Cyber Clinical Environment (CCE). Every effort will be made to coordinate clinical experiences such that students at one university will have an opportunity to conduct interviews and assessments on professional patients at one location while parallel activities are occurring at another site. Sites then could switch patients, such that professional patients at one site could potentially be evaluated by students on all three campuses. This sharing of professional patients is an important consideration in that only one professional patient with a designated condition would be needed to provide students, from all three campuses, an opportunity to asses and interact with a patient experiencing a given condition. Carefully planning these experiences could increase the likelihood that all students graduating from these nursing programs would have a supervised opportunity to assess and interact with individuals with common chronic health problems. Upon completion of these clinical experiences, one faculty member could coordinate a discussion with students from one, two, or all three campuses, using videoconferencing technologies.

NTAI SIMULATION WORKSHOP

Thursday, May 22 and Friday, May 23, 2008

HJF Telehealth Department at Mount Aloysius College

Attendees: Telehealth staff which includes Project Director, Project Coordinator, Lab Coordinator, Network Engineer, and Administrative Assistant, MAC Nursing Instructor for health assessment and expert trainer/presenter.

The completion of Room 322 clinical lab environment has resulted in the exploration of all the possibilities that this setting may have to offer. We decided to schedule a 2 day workshop that would

include some of these possibilities that would directly enhance the nursing learning experience. Our goal was to explore clinical simulation by utilizing the modalities we have access to.

Topics: **Simulation mannequins** (high fidelity vs. low fidelity) reviewed usage in past studies; pros and cons.

Standardized patients; how they are recruited, trained, and used in clinical medical training environments, advantages and versatility.

Remote assessment; tools and equipment that are incorporated in transferring assessment information over distance. What's out there, effectiveness, pros and cons, cost effectiveness, etc.

Videoconferencing; equipment available, comparison of quality and cost, capabilities, portability, etc.

Expert advice was obtained through consultation on the subjects of standardized patients and on content of nursing health assessment curriculum

Objective: We wanted to explore all the possibilities of furnishing the new lab to create optimal usage of the setting (operating room, emergency room, trauma, ICU/CCU, NICU, and many other specialty settings) while staying within our budget confines.

We also wanted to obtain information and education about the use of standardized patients in the application of telehealth.

Outcome: Two phases of the Cyber Clinical Environment study will utilize standardized patients. This workshop provided valuable information to help us recruit and train standardized patients and develop scenarios for this study.

Cyber Clinical Environment Study

Part 1

A pilot study of the CCE was implemented using 20 RN to BSN students enrolled in Mount Aloysius College Nu 302 Health Assessment Class from July 2 through July 23, 2008. Standardized patients were used in the assessment scenarios which took place in a clinical lab setting at the Greater Altoona Career and Technology Center (GACTC). Audio/video conferencing equipment was set up to connect the lab setting to the classroom which was located in the same building, but on a different floor. Interaction between the students, the patient, and the person performing the assessment took place. Remote assessment tools that were used in this study included the derma-scope (skin camera) and ampliphied stethoscope. Assessment scenarios carried out for the study included skin, respiratory, and cardiac. The standardized patients filled out an evaluation on the student doing the assessment. Attitude/satisfaction surveys were filled out by the students that participated in the study. Study activity occurred on three different class nights which coincided with the body system that was presented in the health assessment scenarios.

Figure 1. Assessment being performed on a standardized patient.

Figure 2. Students participating in remote assessment of standardized patient.

CYBER CLINICAL ENVIRONMENT STUDY UTILIZING STANDARIZED PATIENT FOR NU302 HEALTH ASSESSMENT

July 2008

Mount Aloysius College conducted the Cyber Clinical Environment research to evaluate the effectiveness of new technology to enhance the education of students scheduled for Nursing 302 Health Assessment class as participants. Students were asked to interact in a remote health assessment process that involved standardized patients (people that acted as patients). The standardized patient and the nurse performing the assessment were videoconferenced into the classroom which allowed two-way interaction between the class and nurse/patient.

The object of the study was to prove that a simulated clinical education environment would include labs which students would use remote assessment equipment housed at a central station to interview and examine professional patients located in another area of the lab, thus simulating the real-world situation of patients being located a distance from the health care provider. The following scenarios were presented: 1) skin assessment on July 9, 2) respiratory assessment on July 16, and 3) cardiac assessment on July 23. These scenarios were developed for remote health assessment and critical thinking to support decision-making. Each class period lasted approximately 40-45 minutes, depending on the number of students and class interaction.

There were 19/20 participants who returned surveys (10 males; and 9 females). The groups demographics indicated that students 40 years of age and older was (53%); 30-34 years old was (32%); 18-25 years old was 10%; and 25-29 years old was 5%. Regarding RN years of experience, 47% had 1-5 years, 23% had 6-10 years, 12% had 11-20 years, and only 6% had 26-30 years. RN working experience included cardiology, intensive care, emergency medicine, family practice, gastroenterology, med/surg, pediatrics, nursing informatics, operating room, and telemetry. At the conclusion of the third session on July 23, 2008, participants in this study were asked to fill out a survey of 25 questions in sections 1-3 related to their *Cyber Clinical Environment* experience. Following are the results of this study:

Quantitative Data Analysis: (Male and Female students answered all questions in each section very similarly)

Section 1 included 8 questions related to the students' opinions about their telehealth experience showed that communicating effectively with the patient was rated the highest out of 8 questions in this section, (53% strongly agreed and 47% agreed). The second highest (95%) of students indicated they were able to utilize the remote telepresenter to assist with the assessment effectively. The third highest (94%) showed the students' believe telehealth technologies allowed them to make correct evaluations. This section also showed (84%) of students were favorable on telehealth being a valuable tool for nurses, and (79%) could carry out assessments without physically touching the patient. Students also disagreed that telehealth is tedious (57.5%) and complicated (68%). The majority of student's opinion that telehealth could save time was the *only* question in this section that was closely rated by agreement (37%) and disagreement (42%).

Section 2 included 11 questions on students' assessment abilities to communicate via videoconferencing showed that

100% of students agreed to strongly agree that they were able to communicate verbally & overall, and believe the assistant's presenter was useful to them. The second highest (95%) thought they were looking down upon the patient due to camera placement, and thought the lighting during the consult was adequate. The third highest (90%) were able to communicate visually as needed. This section also showed (83%) of students could see the patient well in regards to camera angle and view. Students also disagreed (82%) on their belief that telehealth technologies products decreased their ability to function effectively with the patients, (79%) disagreed they were frustrated when giving directions to the patient, and (68%) disagreed they felt frustrated when trying to complete an assessment using telehealth technologies. Students showed diversity between agreeing (57%) and disagreeing (42%) on their ability to make eye contact with the patient.

Section 3 included 6 questions on overall satisfaction with students' experience showed that (94%) agreed they could envision potential applications for using telehealth; (85%) would likc to have more opportunities to learn about telehealth; and (83%) would consider using telehealth technologies in their nursing practice. Students also disagree ((90%) that they are not interested in telehealth technologies, and (89%) disagree that telehealth applications represent unnecessary health-care expenditures. One final result showed (89%) of students agreed they prefer a face-face consultation over telehealth.

SUMMARY:

This study of NUR302 students documents the potential uses and the values of this methodology in the learning of RN to BSN baccalaureate program.

Part 2

Another planned activity for students in the undergraduate programs includes placing telemonitoring kiosks in assisted living facilities. These devices would be equipped with daily monitoring devices that can be individually configured for specific patient needs. Monitoring devices might include weight scales, blood pressure cuffs, heart rate sensors, pulse oximeters, glucometers, dermatology cameras, wound cameras, ophthalmoscopes, etc. In addition, daily condition-specific questions can be asked and responses monitored. There are formalized teaching programs already programmed into these kiosks that students can review with the patients. Videoconferencing capabilities are available as well. Each site will provide an opportunity for 8-10 undergraduate nursing students to monitor and interact with one individual in an assisted living facility, over the course of a semester. This type of experience at the undergraduate level will assist students in preparing to care for community dwelling individuals with chronic health conditions, provide them with opportunities to demonstrate and refine critical thinking skills, and develop a level of comfort and proficiency with providing nursing care remotely.

Phase 3) Testing, iterative development, and evaluation (Months 9 -12) – Modify approach based on findings from Phase 2; final testing, evaluation, and report writing. Upon completion of the remote clinical experiences, students will complete evaluation forms, indicating their comfort with the technology, their perceived ability to carry out a comprehensive assessment remotely, their perceived ability to communicate effectively and professionally with the patient, as well as the specific positive and negative aspects of the experience. In particular, evaluations will explore aspects of the experience that students feel should be modified to enhance the educational experience. In addition to evaluating thc student performance during the encounter, SP's will be asked to provide feedback about the encountcr from the patient perspective. This information will be used to further refine the protocol. As these individuals have undergone many in-person physical examination procedures with students, we will

attempt to gather information about their perception of the experience, with particular emphasis on what aspects could be improved, and if they believed the assessment was comparable to an in-person evaluation. Again, we will use this information to refine the protocol. Because some faculty, particularly at the undergraduate sites, may have had little experience with these technologies, it will be important to gather assessment data from these individuals as well. In addition to the types of information indicated for students and professional patients, we will gather information about the faculty perceptions of the learning experience for the students, the quality of the encounters, the availability and quality of needed equipment and technology, and any suggestions for further refinement. Evaluations will be used to revise protocols; they will be included in the final report and will be written up for publication. Data emerging from this project will support the value of telehealth technology to prepare students to meet the challenges of 21st century healthcare.

The other activity planned under this initiative specifically for undergraduate nursing students, the placement of kiosks in assisted living facilities, will be evaluated in much the same way. However, this experience will take place over the entire semester, and students and actual patients will be involved. Data will be gathered from the students, patients, and faculty members. One nuance to this experience that we will be able to explore is the ability of the students and patients to set up and keep appointments, the ability of the students to follow up in a timely manner, if indicated, and the effectiveness of using formalized teaching programs to assist in disease management. As noted in the previous example, these data will be used to disseminate the value of this type of educational experience for nursing students, in order to prepare them to meet the ever expanding demands to provide quality healthcare for all. Again, use of this type of approach will help to bridge the barriers of distance and time, while addressing challenges encountered with the nursing faculty and practicing nurse shortages.

Parts of the Cyber Clinical Environment Study took place on two other campuses; USUHS and Marquette University. Following are the two reports from these sites on their studies.

Report from USUHS (site) on "Harnessing Technology to Teach a Dying Art: Using Telehealth Technology to Teach Physical Exam Skills" which was part of the Cyber Clinical Environment study.

Project Number: G261HP

Principal Investigator: Dianne Seibert

Department: GSN

Final Report

Period covered by this report: from January 2007 to December 2009

Publications, Abstracts, and Presentations:

List all manuscripts submitted for publication during the period covered by this report resulting from this project. Include those in the categories of lay press, peer-reviewed scientific journals invited articles, and abstracts. Each entry must include the author(s), article title, journal [book, editor(s), publisher, volume number, page number(s), and date

(1) Lay Press: None
(2) Peer-Reviewed Scientific Journals: None
(3) Invited Articles: None
(4) Abstracts: None

Summarize the progress during the period of this report and its impact on your plans for the remainder of the project.

This project was a sub-project under a larger Telehealth Grant spearheaded by Dr Janet Grady at Mount Aloysius College. The parent grant was to look at the use of Telehealth tools in nursing education programs, and Dr Grady was interested in partnering with the Family Nurse Practitioner students in the Graduate School of Nursing at USU. Her undergraduate students were going to use telehealth technology to remotely evaluate patients in a nursing home setting. The particular tool and patient population she planned to use was not appropriate for students in a Nurse Practitioner (NP) program, however, so this sub-study was designed to meet the learning needs of NP students.

Due to a prolonged continuing resolution, it was over a year before the Office of Naval Research (funding agency) through the Henry Jackson Foundation, released the funds to begin the study. During those intervening months, new telehealth technologies emerged, and the study focus shifted dramatically. This specific protocol was never put into place – instead, two other studies, centering on the newly developed telehealth tools, were designed. Both of the studies were built within the same budget, and they each have their own project numbers.

Summarize the <u>progress</u> during the period of this report toward the achievement of the originally stated aims and list the significant results:

This study was completed by 8 physician providers and 36 students (School of Medicine and Graduate School of Nursing). Providers commented that the tool was useful, but would have been more useful if the images recorded had colors that were more lifelike. They also commented that the "learning curve" for using the hand pieces was step. The students appeared to appreciate the tools for learning difficult physical exam skills, but perhaps more importantly, commented that having access to clinical experts at a point in their career where this expertise could be appropriately appreciates was very valuable. Access to experts when they were very novice learners was not as helpful as access to experts later in their educational programs (as this interaction was). Data was collected anonymously; none of the subjects provided any identifying information on the survey instruments. The GSN faculty & student encounters were video recorded for viewing by the remote nursing students (part of the study design), but these recordings were not used in data collection or analysis.

In layperson's terms, summarize the progress during the period of this report:

This study showed that the use of telehealth tools to teach health assessment skills – even to relatively seasoned clinicians – is very useful. It was difficult to determine how much impact the tools themselves had on the outcome, because just having access to expert clinicians appeared to be helpful in-and-of itself.

In layperson's terms, explain any <u>medical/military significance or implications</u> of your results to date:

This has already had some impact on the educational process within the GSN. During the 2nd year of the program (practicum courses) the faculty is setting up similar instructional sessions with expert clinicians to teach advanced skills using these telehealth tools.

Progress Report

Jill M. Winters, PhD, RN

Marquette University Site

Goals of the project:

1) To develop and evaluate the use of a clinical education environment that will allow students to use telehealth and information technologies to gain proficiency in practicing in a technology-enhanced healthcare system.
2) To provide opportunities for students to develop skills that will transfer from the simulated environment to the real world clinical practice arena.

In order to prepare for the student experience, telehealth equipment was evaluated to determine the most appropriate equipment to purchase for optimal student experiences. Telehealth laboratories were configured. Equipment was purchased and installed. Site PI and student research assistants were trained to use the equipment.
Cases were developed for simulated assessment experiences for the undergraduate students in the assessment course. Along with these cases, evaluation forms were developed, provided standardized patients with a structure for providing students with feedback. Standardized patients were hired and trained. Fifty five subjects (students) have completed two of the assessment experiences to date. Four assessment experiences are planned for the summer students. Preliminary feedback from both students and standardized patients has been very positive.

For the research portion of this project, IRB approval was obtained. Upon completion of the four assessment experiences, students will provide data about their comfort with equipment, ability to carry out remote assessment, comparisons of assessment activities face-to-face and remotely.

The last phase **(Phase III)** of the Cyber Clinical Environment study involved **placing multi-user kiosks** in two different assisted living/managed care facilities and one senior citizen center.

Phase III planned activity included placing telemonitoring kiosks in assisted living facilities. These devices can be equipped with daily monitoring devices individually configured for specific patient needs. Monitoring devices capability includes weight scales, blood pressure cuffs, heart rate sensors, pulse oximeters, glucometers, dermatology cameras, wound cameras, ophthalmoscopes, etc. In addition, daily condition-specific questions can be asked and responses monitored, and formalized patient teaching programs can be implemented and evaluated. Remote assessment equipment was purchased from VitelNet. 3 multi-user kiosks (computers) were placed in three different sites; a managed/assisted living

community, a managed apartment complex, and a senior citizen center. 37 participants with one or more of the following chronic diseases, diabetes, COPD, hypertension, and CHF, met the criteria for the study and were consented and trained on the use of the remote assessment equipment. The kiosks were connected to a database at the college and managed by the project coordinator in making live video connections once a week and monitoring their vital signs that were taken as often as the participant desired. Questions were also asked related to their chronic condition(s) in which they answered on the computer. Education was provided about better self-management of their condition. This study was conducted over six months; June, 2009 through November, 2009.

Concise Accomplishments:

Video connections were done every Tuesday, Wednesday, and Thursday to participants as part of the weekly remote assessment and education related to their chronic disease. Each participant was assigned a day and time to do their video connection. The video connections were scheduled 30 minutes apart, which allowed some extra time for participants to make the connection and take and transmit their vital signs before speaking with the Telehealth nurse. Vital signs that were entered into the computer/database included blood pressure, pulse oximetry, weight, and pulse. Participants with diabetes were asked to enter their glucometer readings. Reports of the participants' vital signs were collected into the database which were printed out and sent to the participants to allow them to share with their primary care doctors and family members. The live connections started the first of June and continued through November, 2009. Questionnaires about their chronic condition were given to each participant before and after the study and results were compared to assess any increase in knowledge. Self-efficacy and satisfaction surveys were given at the end of the study to evaluate the participant's opinions about the study and the technology used in the study. Thirty seven people started the study and 29 completed the study. The equipment set used in the study presented some technical challenges that were not clarified by the vendor prior to the study's implementation. After the study was underway, the vendor made it known that the multi-user kiosk with video had not previously been used in a research application, and this situation resulted in unexpected beta testing of the equipment.

Work Plan:

Our plan for Phase III of the Cyber Clinical Environment study was to finalize data analysis. This project closed December, 2009. All data have been collected, and analyzed. One of our objectives for this phase of the study was to develop and evaluate the use of a cyber clinical education environment that will allow students to use telehealth and information technologies to gain proficiency in practicing in a technology-enhanced healthcare system. We were unable to meet the objective of student involvement, mainly due to the timing of the study implementation which occurred at the end of the spring semester. Because of the academic schedule, nursing students were not able to commit to a six month study that ran through the summer months.

Another objective was to provide a means of remote assessment that afforded the participants the opportunity to learn more about their chronic disease (diabetes, COPD, CHF, and hypertension) and to be better prepared to manage it. Data was gathered from the residents and telehealth staff to evaluate the learning experience and the value of the telemonitoring experience for the residents. Nuances to this experience that we are able to explore include the willingness of residents to set up and keep appointments, the effectiveness of using formalized teaching programs to assist in chronic disease

management, and any association between comfort and acceptance of technology and improved health outcomes and perceived quality of life.

Major Problems/Issues:

Equipment was purchased and training was done with the telehealth staff. The multiuser kiosks were placed in two assisted living facilities and a senior citizen center which all required internet connection which didn't previously exist. Initially, we encountered problems with the live video connections and with information coming into the database. About a month into the study, we were made aware that we were the first to use the multiuser kiosk with live video capabilities. As a result, much beta testing for the vendor occurred. Some data we had intended to collect are missing due to problems with the equipment coupled with the fact that the internet database was not licensed or available to us until the third month of the study. We also experienced some participant attrition.

Technology transfer:

While no direct technology transfer has occurred to date, analysis from this study will be beneficial in planning and implementing future studies involving telehealth technology and chronic disease management for patients in rural community settings. As noted previously, results will be used to disseminate the value of this type of experience to bridge the barriers of distance and time, while addressing challenges encountered with the nursing shortage, particularly as it affects rural areas. From a human factor's standpoint, the importance of participants' attitude toward technology and its impact on program effectiveness is essential information for anyone planning to replicate this study or similar applications.

Cyber Clinical Environment study participant taking his vital signs and participating in live video connection with Telehealth personnel at Mount Aloysius College.

Cyber Clinical Environment Study

Introduction

There is considerable interest in the health care community in developing new strategies that are effective in enhancing the assimilation and retention of information, and the development of skills, necessary for patient self-management of chronic disease such as diabetes, hypertension, chronic obstructive pulmonary disease, and congestive heart failure. People with chronic disease are expected to follow treatment regimens that require a significant amount of knowledge and multiple skills. Educational programs established to target patient self-care are essential for these individuals. Frequent and ongoing reinforcement of this education can enhance motivation and self-efficacy and may be the most valuable part of the education process.

There are many barriers between the patient and the education including the shortage of nurses, shorter hospital stays, limited access to care in rural areas, availability of current, evidenced based education, and limited income/insurance. The timeliness of these issues is emphasized by concomitant changes in societal demographics. The number of elderly patients with chronic diseases is increasing. Many of these individuals remain in the community, in either home or assisted-living settings, often with limited or insufficient access to healthcare services.

In addition to face to face education provided by health professionals, various telehealth and information technologies offer the ability to manage health care data and improve access to health care information (Simpson, 2005). Telehealth encompasses videoconferencing, transmission of still images, e-health, remote monitoring, nursing call centers, use of electronic health records, and continuing health care professional education. The use of telehealth technologies would be especially useful in rural areas, where limited numbers of clinical practice areas exist, travel to and from these locations is problematic.

Benefits of the use of telehealth approaches include increased access to care and more efficient use of resources (Dimmick, Mustaleski, Burgiss, & Welsh, 2000; Peck, 2005). Increased availability of telehealth technology can assist patients to achieve better management of their ailments thus improving self-efficacy. Self – efficacy, a concept from social cognitive theory, has been shown to be related to many positive health behaviors (Hogenmiller, Atwood, Lindsey, Johnson, Hertzog, and Scott, 2007). The primary architect of self-efficacy, Bandura (1994), defines the concepts as peoples "capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p 1). Thus, self-efficacy is expected to promote successful health habits such as self monitoring and self-regulation (Bandura, 2005). Moreover, it is through mastery experiences that self-efficacy is enhanced. Improved self-care, along with increments in self-efficacy, may be expected to increase patients'

perceptions about their quality of life. Positive experiences with the telehealth equipment should also make their attitudes about technology more positive and increase their confidence in the use of computer and televideo equipment.

This pilot study evaluated the effectiveness of weekly remote assessment of residents in assisted living and managed care facilities with chronic diseases (or conditions). The study was designed to explore the following questions:

- How does telemonitoring impact participants' health indices (e.g., blood pressure, heart rate)?
- How satisfied is the participant with thc remote assessment/educational process/
- Are there changes participant's perceived sense of self efficacy in controlling his/her disease(s).
- Is there a change in the participant's knowledge about his/her chronic discase?
- Are the participants willing to accept and use the telehealth technology for management of their chronic disease?

Method

Telemonitoring kiosks with videoconferencing capabilities were placed in assisted living and/or managed facilities (apartment complexes or senior citizen centers). These devices were equipped with monitoring devices that were individually configured for specific patient needs. Monitoring devices included one or several of the following, depending on assessment needs: weight scales, blood pressure cuffs, heart rate sensors, and pulse oximeters. The kiosks also contained teaching materials targeted to the participants' specific learning needs. In addition to measurements from these devices, health providers werc able to ask condition-specific questions with the participant's responses monitored.

A telehealth registered nurse followed participants for a total of six months. The nurse monitored all data collectcd through the VitelNet database. Participants were encouraged to enter their vital signs daily, Monday through Thursday if possible, but at least once a week. The database was checked at least once a day, Monday through Thursday by telehealth research staff. Participants were advised that the VitelNet equipment was not to be used as a substitute for obtaining medical attention.

Live televideo connection with a telehealth registcred nurse was scheduled oncc a week on a mutually agreed upon day and time. During the weekly televideo conferences, the nurse responded to the participants' individual concerns and questions, and reinforced informational content provided in the teaching materials. In the event that data being entered by a participant was abnormal, the participant was advised by the telehealth registered nurse to report these results to his or her physician. If the abnormalities were considered to put the individual at risk for an event, the participant as well as the manager/director of the facility was notified. Notifications as well as follow ups were documentcd.

Data was gathered from the participants and telehealth staff to evaluate the learning experience and the value of the telemonitoring experience for the residents. Nuances to this experience that we explored include the willingness of participants to set up and keep appointments, the effectiveness of a formalized teaching programs to assist in chronic disease management, and any association between acceptance of technology and improved health outcomes and attitudinal measures such as self-efficacy and perceived quality of life.

The participants' attitudinal data were obtained via self-report questionnaires. Five short questionnaires were constructed: comfort/competence with technology, self efficacy, quality of life, acceptance of telemedicine equipment, and satisfaction with current life situation. In each case items were written to have face validity and the reliability on each questionnaire was assessed in terms of Coefficient Alpha (Cronbach, 1951). From Table 1, showing the number of items and the Coefficient Alpha for each scale, we can see that four out of the five questionnaires have high reliability and one demonstrated moderately high reliability.

Table 1. The Number of Items and Reliability for Each of the Five Attitudinal Questionnaires

Scale	**No. of Items**	**Coef Alpha**
Quality of Life	6	0.85
Satisfaction with Current Life Situation	7	0.92
Self Efficacy	18	0.73
Comfort/Competency with Technology	9	0.94
Acceptance of Telemedi Equipment	6	0.91

Results

Thirty seven participants started in the program; of these 29 completed the six-month program. The participants were distributed across three facilities.

We analyzed the participants' pre- and post scores on the knowledge test about their chronic disease and on four of the self-report questionnaires: 1) comfort/competence with technology, 2) self efficacy, 3)

quality of life, and 4) satisfaction with current life situation. We hypothesized that participation in the program would increase the participants' scores on each of these variables. We found a significant improvement in the participants' self-efficacy scores ($t(25) = 2.98$, $p<.03$, one tail; see Figure 1). None of the other attitudinal measures or the knowledge measure changed significantly from the pre to the post test. We also analyzed the participants' vital sign data taken over the course of the study, but found no significant patterns of change over time.

Figure 1. Change in Self Efficacy from pre to post study measurement

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At the end of the study we administered a fifth questionnaire that assessed the participants' acceptance/satisfaction of telemedicine equipment they used during the study. We dichotomized the scores at the midpoint (3.92 on a 5-point scale) and, based on their scores, classified participants as either high or low on acceptance of the telemedicine equipment. We used this as an independent variable to analyze the post-study knowledge test and the four questionnaire scores. We hypothesized that those who were more favorable towards the telemedicine equipment would have higher scores than those who were less favorable.

We found that those who were more favorable toward the equipment had significantly higher scores on the post-test knowledge test ($t(26)= 1.82$, $p<.05$, one tail; see Figure 2). As one would expect, the analysis also showed that those who were more satisfied with the telemedicine equipment had significantly higher scores on their comfort with technology ($F(1, 25) = 6.46$, $p < .02$; see Figure 3.)

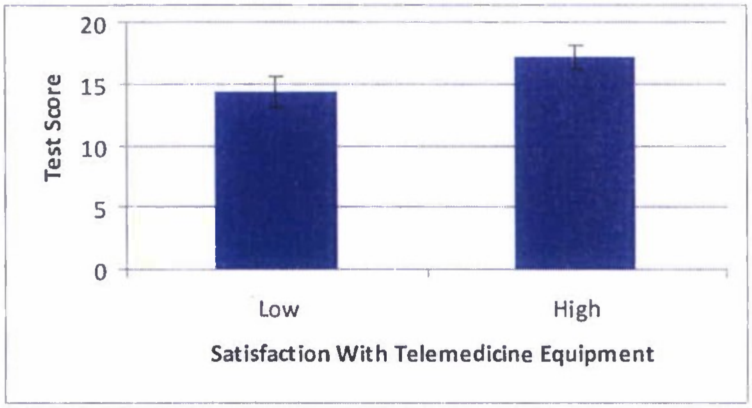

Figure 2. Post test knowledge scores for those low and high on satisfaction with telemedicine equipment

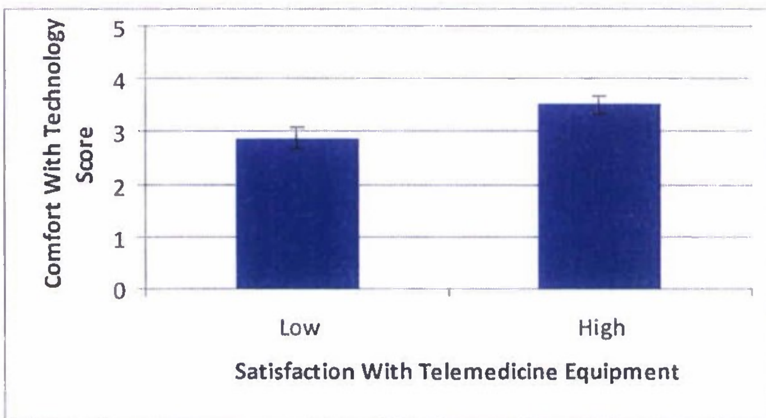

Figure 3. Post-test measure of comfort with technology for those low and high in satisfaction with the telemedicine equipment

To further explore the impact of comfort with technology, we conducted a within-between analysis of variance (ANOVA) with time (pre, post) as the within subjects variable and satisfaction with the telemedicine equipment (low, high) as the between subjects variable. We hypothesized that there would be a significant interaction term – specifically that the post-test scores for those who were more positively disposed toward the equipment would be higher than their pre-test scores whereas the post test scores for those less positively disposed to the technology would stay constant or even decrease. We found a significant interaction on three of the dependent variables: comfort with the technology ($F(1, 25) = 4.38$, $p < 05$), quality of life ($F(1, 23) = 11.91$, $p < .003$), and satisfaction with current life situation ($F(1, 24) = 9.03$, $p < .007$) (see Figures 4, 5, and 6, respectively). Consistent with our hypothesis, those who were more satisfied with the technology tended to increase on these variables from the beginning to the end of the study whereas those who were less satisfied with the technology decreased from the pre- to the post-study assessment.

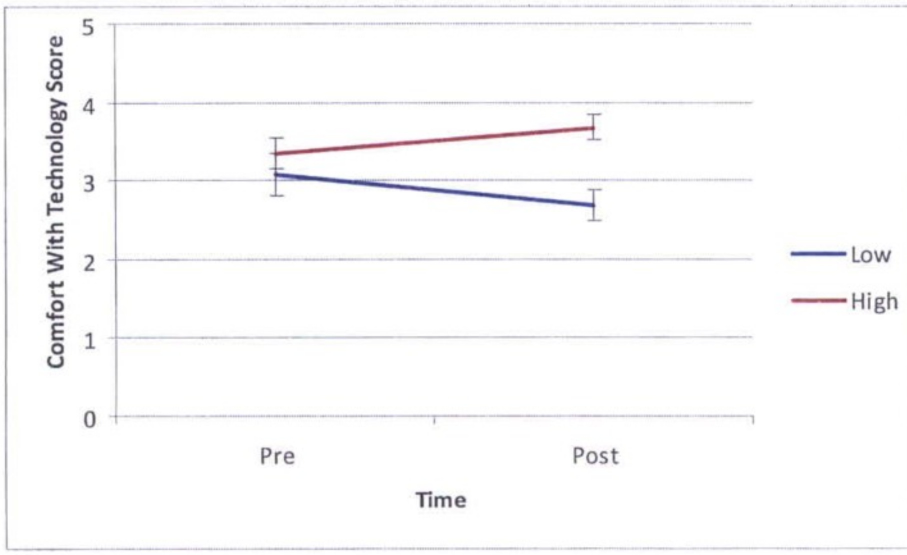

Figure 4. Pre- and post-study measures of comfort with technology for those low and high in satisfaction with the telemedicine equipment

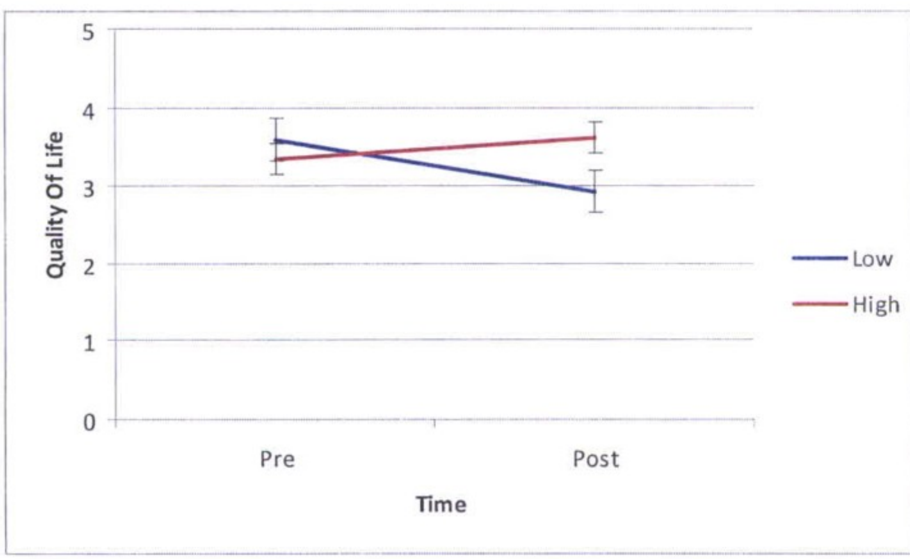

Figure 5. Pre- and post-study score on quality of life for those low and high in satisfaction with the telemedicine equipment

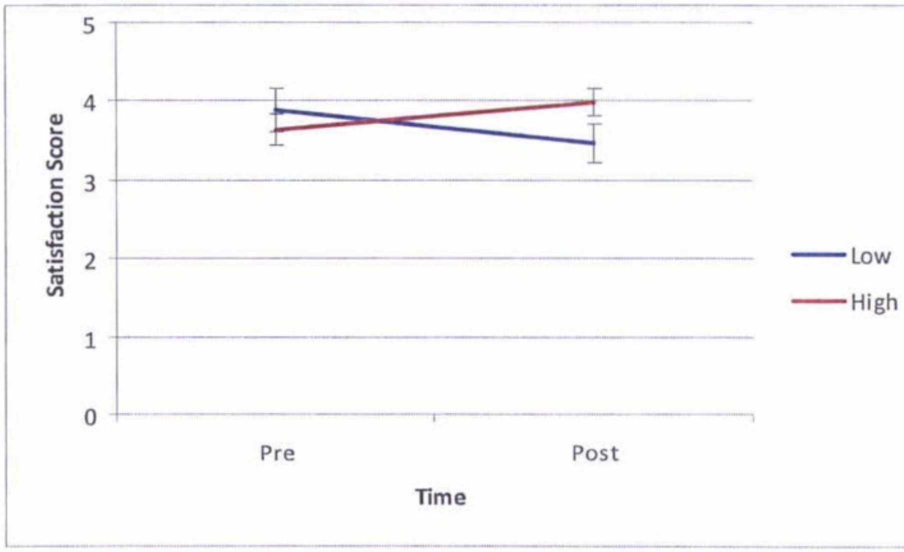

Figure 6. Pre- and post-study score on satisfaction with current life situation for those low and high in satisfaction with the telemedicine equipment

During the six-month period in which the study was conducted, participants could have attended up to 25 weekly televideo sessions with the nurse. As a way of gauging the participants' commitment to the televideo sessions, we counted the number of sessions each participant participated. We found a wide variation in frequency of attendance, ranging from none to 21. Reasons offered for missing sessions included illness, vacations, and medical appointments. We hypothesized that those who attended a greater number of sessions would benefit more as reflected in an increase in knowledge scores or changes in attitudinal scores from the pre to post test assessment. To test this hypothesis, we divided the sample at the median (11.0) into more and less frequent participants. However, we found no relationship between frequency of attendance and either scores on the knowledge test or the self-report questionnaires, suggesting that frequency of attendance per se did not impact the effectiveness of the program on knowledge or attitudinal measures we collected.

Discussion

It is important for the nursing profession to evaluate, use, and recommend best practices for the application of technology in health care and education. The results of this study showed that exposure to and use of the telemedicine equipment and the weekly discussion with the nurse increased the participants' feelings of self efficacy. The increase in self efficacy from the outset to the end of the study period that was observed in this study parallels the increase in self-efficacy observed in another study in which chronic heart failure patients who experienced periodic televideo sessions also increased in self

efficacy (Grady et al., in preparation). Participants' remarks at the end of the study indicated that it made them more attentive to, and aware of changes in, their vital signs.

While there was no increase in participants' knowledge about their disease, the higher knowledge post-test scores for those who were more satisfied with the telemedicine equipment may suggest that a more positive attitude towards the equipment motivated them to take advantage of the information that was available, as reflected in their higher test scores.

The results showed there were no overall changes in participants' perceived quality of life until participants' disposition to the telemedicine technology was taken into account. Those who were more favorably disposed to the telemedicine equipment showed an improvement in their reported quality of life and satisfaction with their life situation while the quality of life and satisfaction scores for those less positive about the equipment tended to decrease. It would seem that if one is not satisfied or accepting of the telemedicine technology that tends to translate into resistance and the technology has little or no effect to help. If one, however, is accepting and open to the technology it can aid and abet quality of life.

The finding that satisfaction with the telemedicine technology facilitates a higher quality of life implies that in health maintenance programs using telemedicine equipment, it is important that the equipment works without glitches. There were some problems with the technology during this study, particularly at the outset, but we do not have sufficient data in this study to analyze whether there was any relationship between the number of times the participants experienced problems and their satisfaction with the telemedicine equipment, nor whether encountering problems deterred further participation. Regardless of any problems experienced, as indicated in the results, many of the participants were positive about the technology.

Conclusions

Overall, the telemedicine program was encouraging in that participants were accepting of the technology, and participation enhanced their sense of self-efficacy. Another encouraging result was the finding that for those who were more satisfied with the technology, perceived quality of life increased from the start to the end of the program. These findings point to the use of telemedicine and video communication as a positive alternative to face to face health care.

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Task Two) Deliverable: Report outcome analysis of experiments to evaluate the impact of simulator-based education:

Goals: Develop/conduct/evaluate experiments to provide evidence for best practices in the use of simulation-based education for Nursing and Allied Health students.

Simulation study #1 (nursing)……………………………………………………………………………

Simulation study #2 (radiography)……………………………………………………………………

Simulation study #3 (nursing)……………………………………………………………………………………………

Simulation Study #1

January 23, 2007

Nursing Skill Simulation Learning Protocol

Background

Simulation has been used for decades by the military, aviation, transportation, and most nuclear power industries. In the United States as well as other countries, organizations have invested heavily in training tools, educational materials, and simulation technology during the last decade. United States Departments of Defense, Justice, and Health have expended numerous efforts to examine the best ways to create training simulations, course material, and scenarios that most effectively meet training needs (1). Simulation has been successfully used in the health carc education arena as a teaching strategy for clinical and formal education. This technique has been used in nursing schools for fewer than 10 years and many nursing schools have not yet explored the various ways in which human patient simulation can be used in instruction (2).

At present, the use of threc-dimensional simulation to reproduce life-like experiences in order to improve the training of health care professionals is developing at an unprecedented pace. Several challcnges in today's health care community have promulgated the need for cost-effective and efficient innovativc strategies that teach nursing students about real world nursing in a simulated environment. As health care treatment methods continue to improve, the demand for qualified health care professionals has increased in the midst of a nursing shortage. The capacity to train new nurses to meet the needs of health care organizations is diminishing while greater public concern for patient safety exists. Increased patient acuity, shorter patient hospital stays, and an increasingly complex clinical environment with increascd use of technology are situations that require adequately prepared nurses. Nursing faculty shortages, greater numbers of students, and a growing knowledge base are other factors impacting the preparation of future nurses. Ill-prepared nurses face fast-paced practice settings, heavy workloads, and limited supervision. It is imperative, therefore, that nurses new to the workforce are confident, competent, and develop good clinical thinking skills. A health care professional's ability to react prudently in an unexpected situation is a critical factor for positive outcomes to result. This ability is learned and dcveloped over time with training, practice, and repetition.

In nursing education, clinical simulation represents a revolutionary technique in which students practice nursing decision-making and treatment skills on lifelike, high-technology manikins. Simulation is defincd as a teaching method in which learners practice tasks and processes in real- world type circumstances using models or virtual reality with feedback from instructors and peers (3). It is belicved that the role of practice in the mastery and retention of a skill is essential while attempting to learn a skill and, after initially learning it, to maintain proficiency (4).

The use of human patient simulators provides a safe learning environment that allows students to become better equipped to handle a variety of circumstances without jeopardizing real patients. Situations that students may never encounter in their clinical rotations can be "simulated" in the lab wherc faculty can allow students to make mistakes and see thc consequences of their errors. Students can not only learn patient-care skills, but also build confidence in their own critical thinking and decision making skills without causing discomfort or danger to real patients. Simulation with high-fidelity manikins provides an opportunity for students to "think on their feet", to develop reflection and analytical skills, and to

consolidate clinical management, and organizational skills. Learners need sensory input from the task and feedback related to performance to reinforce meaningful skills learning (5).

The use of simulation provides value to nursing educators for its ability to mirror changing medical conditions reflected in physical changes and patient comments. Faculty can develop complex and changing exemplar case study scenarios for programming the virtual patient's condition. Such scenarios help students develop critical thinking skills and assessment abilities in a non-threatening environment.

The use of scenarios allows students to assess a critical health incident through measurement of physical parameters and communication with a "patient" to determine appropriate interventions, real-time response, and evaluate and identify the need for further intervention (6). Simulation provides an experiential learning strategy for decision-making that focuses on process, including the use of clinical information and information-processing sequence rules for use for combining information and decisions made. The development of clinical decision-making involving higher cognitive skills is critical to the safety and outcomes of patients.

Research has demonstrated the value of simulation in preparing nurses for clinical practice. The results of research suggest that reactive simulation training in nursing education is more beneficial in increasing skills and knowledge than traditional methods (3). The literature indicates that compared with traditional methods, simulation provides more realistic experiences, enhances the acquisition and retention of knowledge, enhances critical thinking and psychomotor skills, increases learner self-confidence, and is perceived to be more satisfactory for the students (4). Studies have also shown that participation in experiential learning improved the ease of transition of beginning nursing students into their first clinical rotation (7).

While simulation techniques seem to offer many advantages for nursing education, several barriers also exist. Reactive simulation utilization has a financial impact on resources for developing and maintaining these programs. Also an extensive faculty commitment is necessary and can be very time-consuming. In addition, while it has been well documented that simulation is valuable in preparing nurses for clinical practice, the evidence of the actual effect relating to preparing nurses for decision-making is inconclusive. And, perhaps most significantly, the transference of learning to actual clinical procedures is not well-documented (8).

Technology-centric learning environments with telehealth technology tools and simulation labs housing varying degrees of fidelity may enable the best possible learning experience for nursing students. Schools of nursing and other academic institutions need to develop, implement, and evaluate simulation used for teaching strategies for best practices in education. The Division of Nursing at Mount Aloysius College in west-central Pennsylvania will conduct a replicated research study to further investigate the effectiveness of simulation compared to traditional techniques.

2.0 Research Design and Methods

1.) Design

This study is an enhanced replication of the of the Simulation by Learning Protocol approved and conducted at Mount Aloysius College in Spring semester 2006. It is designed to determine if simulation-based learning is more effective than traditional methods. This is a prospective, experimental study with two intervention groups using a post-only control design The study will attempt to answer the following research questions:

- Is simulation-based training more effective than traditional methods?
- Are students satisfied with this method of learning?
- Are faculty satisfied with this method of teaching?

Intervention

A training protocol has been developed for the testing of two skills: foley catheter insertion and nasogastric tube insertion. Students will be randomly assigned to one of two groups. During the first half of the semester, students in Group I will be taught nasogastric insertion using reactive simulation manikins following faculty demonstration on SimMan, an advanced, high-fidelity manikin . Group II students will be instructed in nasogastric insertion using traditional, static manikins. All students will be instructed in other skills using the reactive simulation manikin during this time prior to study testing. Practice sessions will be scheduled for students using the type of manikin appropriate according to their group/skill. Open practice sessions will also be available for skills other than those designated for testing on designated skills. Testing for NG insertion will occur at mid-term by adjunct faculty blinded to training techniques.

In the second half of the semester, Group I students will be taught foley catheter insertion using traditional, static manikins while Group II students are taught this procedure using reactive simulation manikins. Again, all students will be instructed in other skills using the reactive simulation manikins prior to testing. Practice sessions as described above will also occur. Testing for this skill will occur at the end of the semester.

In addition, testing outcomes will be linked to cognitive outcomes resulting from test questions that will be included on the final exam. This analysis will allow us to look beyond the impact of simulator fidelity on skill training, and examine whether simulator fidelity impacts students' understanding and ability to reason about the task.

Testing

All students will be tested using the reactive, simulation manikins. Testing will be conducted as follows: four testing stations will be set up with two faculty persons at each station. Appointments will be scheduled for all students. Four students will be tested simultaneously. Approximately one-fifth of the students will be designated as "foils". These students will be tested on a different skill. The purpose of the foils is to counter-act any information passed on by those who have been tested to those who have not that may indicate that only one or two procedures are being tested.

The observation instruments to be used will allow a subject matter expert to reliably and validly evaluate the performance of the students as they perform the skills (Appendix A, B). The instrument utilized in the initial simulation protocol has been modified somewhat to capture more discriminating data. Two questionnaires will be completed by the students. One will measure student satisfaction with this method of learning as well as perceptions of self-efficacy (Appendix C) and will be completed following training. The second one will capture students' perceptions of the learning experience (Appendix D) and will be completed following the testing. The cognitively-based questions about the target procedures will be incorporated into the students' final exam. Results of those specific questions will be computed as a separate score and used in this study.

3.0 Data Collection and Statistics

1.) Sample size
Subjects will be recruited from the Nursing 130 seminar class scheduled for the spring Semester in 2007. All students attending this class will be invited to participate. We estimate that the

sample of 50-60 students will yield moderate effect sizes (0.4-0.6) and will have moderate power (0.6-0.7).

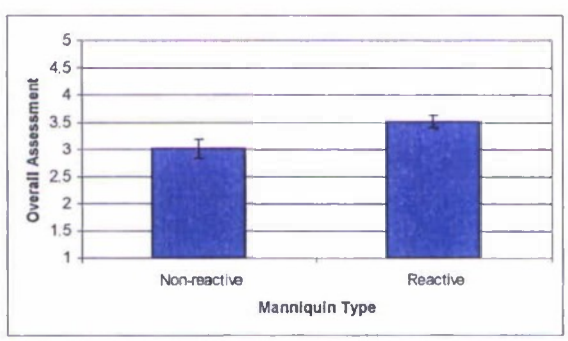
2) Statistical Methods

The two independently completed observer instruments for each student will be compared and large differences (more than 2 scale point difference) in task ratings will be adjudicated. The reliability of raters in terms of coefficient alpha will be computed for each pair of raters across common students. The rating instruments will be summed across tasks to arrive at a total rating or score. The two total rating scores for each student will be averaged to produce the first performance measure. The two responses to the overall rating item for each student will also be average to form the second performance variable.

The two performance measures will each be subjected to between-subjects ANOVA. Thus, performance means derived from the traditional (non-reactive manikin) training condition will be contrasted with means derived from the experimental (reactive manikin) training condition. A main effect indicating that the experimental condition means are significantly larger than the traditional condition means will provide confirmation of the hypothesis. Effect sizes and confidence intervals will also be computed and displayed.

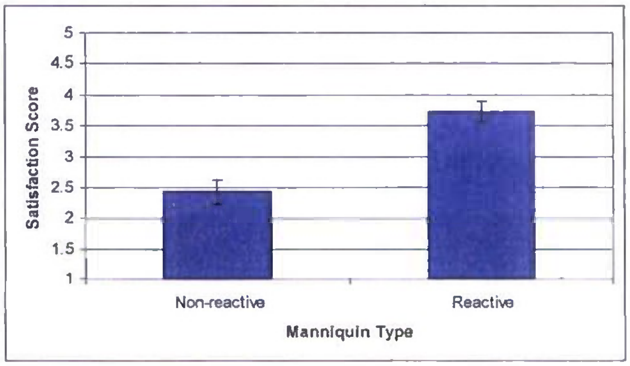
We also expect that a similar analysis carried out for the self-report attitudinal scales will show more positive attitudes for the experimental training condition. The students' scores on the cognitive questions will be summed, and used in similar between-subjects ANOVA as described above. A significant difference in the mean scores in favor of the experimental condition would suggest that the reactive manikin enhances cognitive understanding of the tasks.

Raters' Overall Assessment of Ability to Perform Nasogastric Procedure



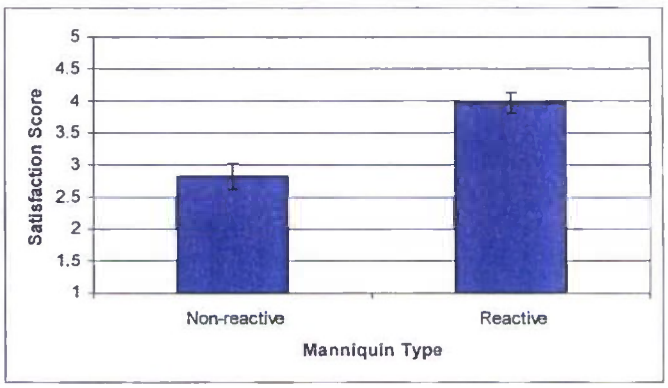
T (df=52) = 2.54, p<.015

Students' Assessment of Realism of Feedback to Actions

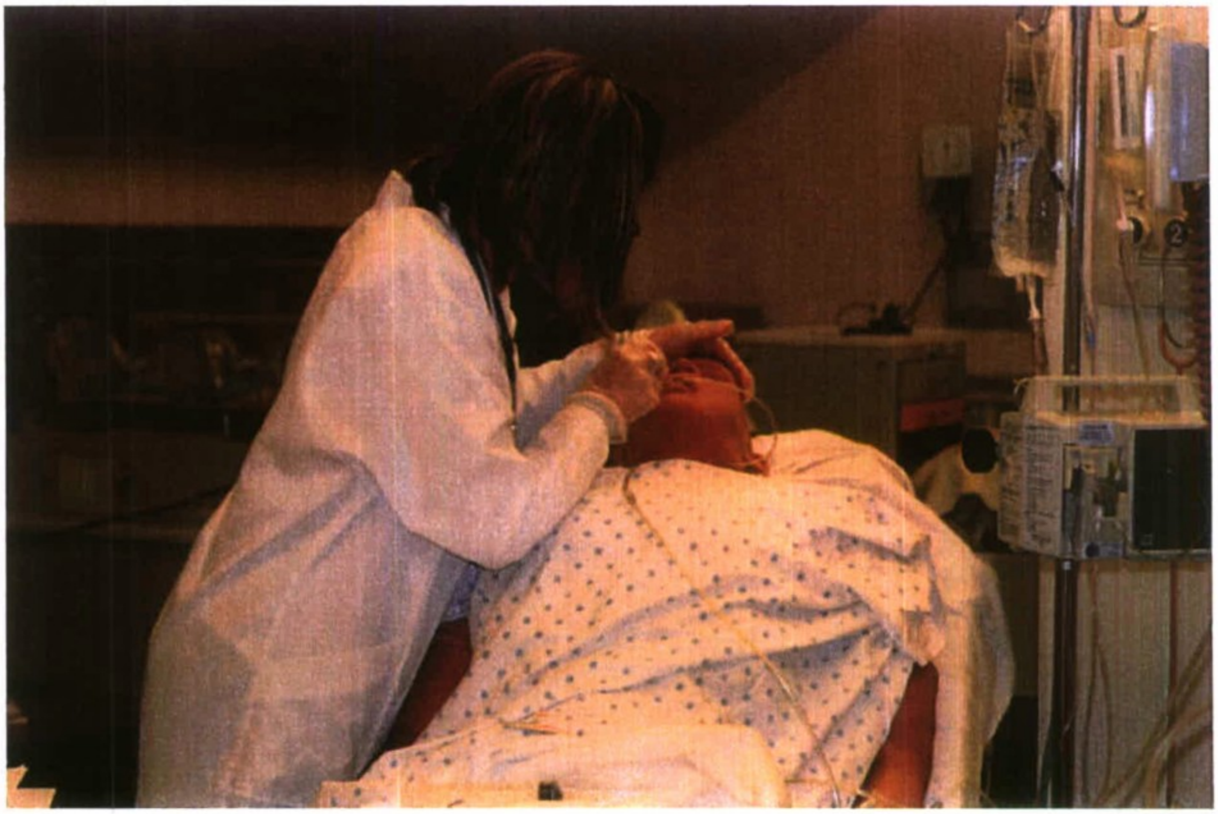


T (df=51) = 5.32, p<.001

Students' Assessment of Helpfulness of Manniquin Responsiveness



T (df=52) = 4.59, p<.001



Nursing student inserting nasogastric tube using a reactive (high fidelity) simulation manikin.

The Impact of Mannequin Simulator Fidelity on the Learning of Basic Nursing Procedures

Introduction

Background

Simulation-based experiential learning programs offer great training promise across a variety of educational domains and contexts. In health care, simulation has been used for both formal and clinical education (e.g., Gaba, Howard, & Fish, 2001; Gordon, Wilkerson, Shaffer, & Armstrong, 2001; Marshall, Smith, Gorman, Krummel, Haluck, & Cooley, 2001; Yaeger, Halamek, Coyle, Murphy, Anderson, Boye, Braccia, McAuley, & DeSandre, 2004), and offers a realistic hands-on medium for acquiring basic skills. A large number of schools and training organizations are presently using simulation-based training to complement their classroom pedagogy (Eder-Van Hook, 2005; Kapur & Steadman, 1998).

Emerging evidence that simulation-based training enhances performance leads to a question about the level of simulator fidelity that is required to maximize training effectiveness. High-fidelity simulators are more life-like, and react to inputs in a realistic way, potentially leading to strong educational benefits. In contrast, low-fidelity mannequins capture basic anatomical structure, but they do not mimic any of the physiological and behavioral reactions that a real patient would exhibit and a high-fidelity mannequin can produce. A review by Issenberg, McGaghie, Petrusa, Gordon, & Scalese (2005) suggests that high-fidelity feedback that accurately mimics realistic human dynamics is one of the primary simulator components that promotes pedagogical effectiveness.

But utilizing reactive simulation invokes a nontrivial financial impact on resources for developing and maintaining training programs. High-fidelity mannequins are more expensive than low-fidelity ones, are more costly to maintain, and are more difficult to move around. Moreover, a time-consuming and extensive faculty commitment is required to operate and maintain high-fidelity mannequins. To justify the extra financial cost and other resources that high-fidelity mannequins require, it is prudent, if not necessary, to have evidence that they provide better training than traditional methods using low-fidelity mannequins.

Grady et al. (in press) addressed the question of whether learning entry level nursing procedures using high-fidelity reactive mannequin is superior to learning with a low-fidelity mannequin. The authors hypothesized that training supported by a reactive mannequin simulator that provides a better analog to the real world will produce a better training milieu and eventuate in higher performance than training supported by the legacy static mannequin that does not provide as close an analog to real-world experiences. They examined the impact of high- versus low-fidelity mannequin levels on the learning of two common nursing procedures: nasogastric tube insertion (NG) and indwelling urinary catheter insertion (UC). They found that training with a high-fidelity mannequin resulted in significantly higher performance than training with a low-fidelity mannequin, and that participants expressed more positive attitudes toward the high- than the low-fidelity mannequin, especially relative to its realism and responsiveness. The study also examined the impact of gender on the acceptance of simulation-based training technologies. Results indicated that males were more positively disposed to training under the high-fidelity mannequin, and benefited from training in that condition more than did the female participants.

Study Objectives

Grady et al. (in press) reported a significant effect of training under a high versus low fidelity mannequin, but the effect size was small and the interaction between mannequin fidelity and gender was only marginally significant. The present study was in part designed to ascertain whether the Grady et al. (in press) results could be replicated. The study was also designed to explore in greater depth how mannequin fidelity impacted each of the nursing procedures being trained. Although in general the design and procedure followed in the present study were similar to that used in Grady et al. (in press), we changed several aspects of the procedure and measurement in order to strengthen the study design, sharpen the measurement instruments, and develop measures of sub skills for each procedure to learn whether all aspects of the procedure are equally affected by mannequin fidelity or whether some aspects benefit more from mannequin fidelity than others.

The first change from Grady et al. (in press) was to develop a more fine-grained evaluation instrument used by subject-matter expert observers to assess performance on each of the nursing procedures. To accomplish this, the skills involved in each procedure were decomposed into discrete actions, each of which was assessed as properly performed or not properly performed. Further, for each procedure, the actions were grouped into subcomponents of the overall procedure. In contrast, the evaluation instrument used in Grady et al. (in press) included a smaller number of more global items, each assessing an aspect of the procedure. Performance on each item was evaluated using a Likert-type scale. By decomposing the skills down into finer-grained steps, we felt we would be able to more precisely pinpoint the impact of any differences that occurred in training under a low versus a high fidelity mannequin.

A second change involved practice. A number of participants in the Grady et al. (in press) study mentioned on the post evaluation questionnaire that they would have liked more opportunity to practice the skill on the mannequin than was available in the class period in which it was trained. In the present study, participants were afforded the opportunity to practice the skill (using the same level of mannequin

on which they were trained) at a designated time. The opportunity to practice the skill strengthened any differences that might occur in training under the two different types of mannequins.

Finally, in the Grady et al (in press) study, the evaluation for both skills was done during the final exam period. In this study, the evaluations for the two skills were conducted at separate times, closer to when they were trained.

In addition, we also wanted to examine whether mannequin fidelity level impacted participants' knowledge about the procedures as reflected in their scores on relevant skill-oriented questions items in the final exam. (For example, in the NG procedure, what is the appropriate action to take if the patient gasps, coughs, or does not respond vocally to questions when the nurse is inserting the tube?) Although as a written test, the final exam necessarily assessed knowledge (what to do) rather than skill (how to do it), we hypothesized that the more lifelike aspects of the high-fidelity mannequin may have motivated better retention of knowledge. This would be consistent with the Alinier and colleagues' (2006) findings that students who received supplementary scenario-based training using an intermediate fidelity had higher scores on the Objective Structured Clinical Examination than students who followed the normal curriculum.

Method

Participants

The participants in this study were students from first year nursing education classes who signed the consent form. A sample of 54 participants, consisting of 43 women and 11 men, was obtained.

Independent Variables and Design

The independent variables and design were adapted from Grady et al. (in press). Two nursing procedures were studied: nasogastric tube insertion (NG) and indwelling urinary catheter insertion (UC).

The first independent variable was training mannequin fidelity manipulated over the levels of low and high fidelity. A non-reactive partial torso mannequin focusing on the anatomical area of interest was employed for the low fidelity level, whereas a reactive full body mannequin was used for the high fidelity level. For the NG procedure a head and chest model that allows a tube to be inserted in either nostril and for the UC procedure a lower torso catheterization model that allows for a tube insertion were the partial torso models used in the low fidelity condition. Neither of these partial torso models was reactive in any way. The Laerdal™ SimMan™ Universal Patient Simulator was used for both NG and UC training in the high fidelity condition. The SimMan™ mannequin, in addition to being anatomically correct, is reactive to various student actions such as saying "ouch" and gagging. If the procedure is carried out correctly, for the UC procedure "urine" is obtained and for the NG procedure "body fluids" are obtained.

As in the Grady et al. (in press) study, the second independent variable was the participant's gender.

The students were trained on both procedures as part of the course curriculum. Two experimental conditions were created. A random half of the participants were assigned to an experimental condition in which NG training was performed with a high-fidelity mannequin followed by UC training with a low-fidelity mannequin. The remaining participants experienced a condition in which NG training was performed with a low-fidelity mannequin followed by UC training with a high-fidelity mannequin. Pedagogical constraints precluded the counter-balancing of the order in which participants were trained on the two nursing procedures.

Dependent Variables

A targeted observation instrument was derived from materials traditionally used to evaluate NG and UC performance. Each instrument consisted of a number of actions necessary to perform the specific nursing procedure. Each action was accompanied by a bivariate yes-no scale. If the action was observed to be correctly performed, yes was checked to indicate successful completion of that action. If the action was not performed or was performed incorrectly, no was checked. The NG observation instrument was comprised of 35 items, and the UC instrument contained 39 items. The items were developed so that subscales assessing specific aspects of the two nursing procedures could be measured. Some of the subscale categories addressing pre and post insertion activities were the same for both procedures, but necessarily the subcategories that reflected the procedure itself were different. For the NG procedure the items were grouped to assess five subskills: prior-to-procedure preparation, bedside preparation, tube insertion, verify and secure, and documentation. For the UC procedure the items were grouped to assess six subskills: prior-to-procedure preparation, bedside preparation, sterile field preparation, catheter insertion, post-catheter care, and documentation. For both the overall scores and the subskill scores, a participant's score was the percentage of items that were checked yes.

Two experienced observers rated each participant on each procedure. The observers were blind to the condition under which the participant trained. To assess the inter-rater reliability for the assessment of each nursing procedure, the mean scores derived from rater 1's observations and the mean scores derived from rater 2's observations across all participants were correlated and analyzed to yield Coefficient Alpha reliability statistics (Cronbach, 1951). In the same manner the inter-rater reliability assessments for the subskills associated with each nursing procedure were derived. The interrater reliabilities for the overall and the subskill scores are shown in Table 1. The reliability for the overall score was high for both procedures. With the exception of UC documentation, all the subskills were assessed with adequate to high reliability. Although the inter-rater reliability of documentation is quite low it does not appear to detrimentally affect overall reliability of the UC instrument. Moreover, none of the analyses examines the subskills individually so this one instance of low reliability can be tolerated.

Table 1. Interrater Reliabilities for the Two Nursing Procedures

NG	**Reliability**	**UC**	**Reliability**
Overall	0.86	Overall	0.88
Subskills		**Sub skills**	
Prior to procedure prep	0.89	Prior to procedure prep	0.88
Bedside preparation	0.74	Bedside preparation	0.63
		Sterile field preparation	0.54
Tube insertion	0.47	Catheter insertion	0.80
Verify and secure	0.87	Post catheter care	0.80
Documentation	0.84	Documentation	0.17

For each procedure two self-report instruments described in Grady et al. (in press) were administered. The Post-Training Questionnaire, which assessed attitudes about the mannequin-based skill training, was completed by all participants at the end of the NG training and again after the UC training.

The instrument was comprised of eight items and had a reported reliability coefficient of 0.88. The Post-Evaluation Questionnaire, which addressed participants' assessment of their performance on the test, their confidence in their ability to perform the procedure, and their opinions about the training they received, was completed after the test on the NG procedure and again after the test for the UC procedure. Because the Post-Evaluation Questionnaire assessed multiple factors, positive intercorrelations among the items were not expected; thus, Coefficient Alpha reliability was not computed.

Procedure

As part of their introductory nursing course participants were trained on the NG procedure and several weeks later the UC procedure. The training was done as part of the regular classroom/lab curriculum and all participants were afforded some hands-on experience. At the completion of each training period participants completed the Post-Training Questionnaire.

Following the training, but prior to testing, practice sessions were schedule in which the participants had the opportunity to practice the nursing procedure using the type of mannequin appropriate to their group and nursing procedure. For each procedure, participants were tested within four weeks after training. (Testing on the NG procedure was done as part of the midterm examination. Testing on the UC procedure was done as part of the final exam.) All testing was completed using high fidelity mannequins. The assessment for each participant lasted approximately 30 minutes.

At testing time a participant entered a testing station and was instructed to perform the targeted nursing procedures. Two subject matter expert (SME) observers were present at the station and each independently evaluated the participant's performance using the observational assessment instrument. At the conclusion of testing the participant completed the Post-Evaluation Questionnaire. At the conclusion of the course participants were debriefed as to the nature of the experiment.

Results

Performance Results

<u>Overall Measures:</u> One purpose of this study was to see if we could replicate the Grady et al. (in press) findings of a main effect due to fidelity and a gender by fidelity interaction. A comparable analysis for the present study is summarized in Fig. 1. The gender (2) X fidelity (2) mixed ANOVA failed to reveal any significant main effects or interaction, $Fs \leq 1.0$, ns. Initially, then, the results of this study do not appear to replicate the Grady et al. (in press) findings. However, inspection of the means pattern in Fig. 1 indicates that the fidelity effect is present for the women but not for the men in the sample. A one-way ANOVA for mannequin fidelity for only the women in the sample showed that women who trained with the high fidelity mannequin ($M = 82.49$) outperformed those who trained with the low fidelity mannequin ($M = 78.14$, $F(1, 40) = 4.28$, $p < .05$). No such effect was present for the men. Thus, in this study the finding reported by Grady et al. (in press) that training with a high fidelity reactive mannequin resulted in higher performance scores was replicated for the female component of the sample. This result is in contrast to the Grady et al (in press) study, where the advantage of the high-fidelity mannequin was stronger for the males than the females. The implications of these results will be taken up in the next section in more detail. Moreover, because a significant gender effect was not found, it was dropped as an independent variable in all subsequent contrasts.

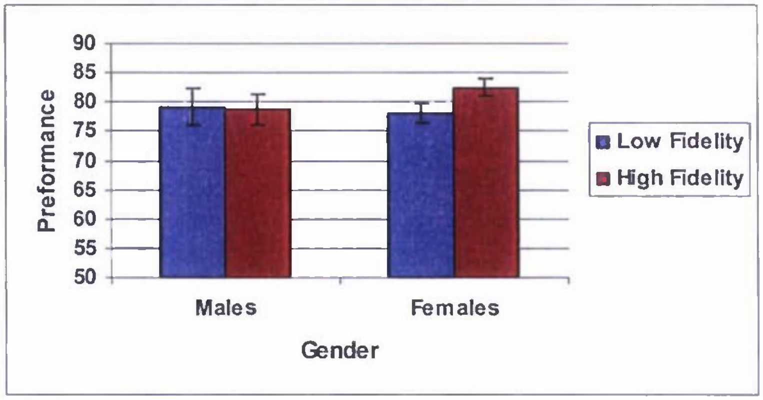


Figure 1. Performance Scores the Low and High Fidelity Mannequin Training Conditions for Male and Female Participants

A second purpose of the present study was to look more closely at how training mannequin fidelity impacted performance on each of the two procedures. For this, 1-way between-subjects ANOVAs were computed for the NG and UC procedures. As Fig. 2 shows, for the NG procedure participants who trained with the high fidelity mannequin earned higher test scores than those who trained with the low fidelity mannequin, $F(1, 52) = 7.44$, $p < .01$. The same analysis for the UC procedure, also depicted in Fig. 2, failed to yield significant results ($F \leq 1.0$, n.s). Thus, there is evidence that the fidelity of the mannequin did not impact the participants' training on the two procedures in the same way.

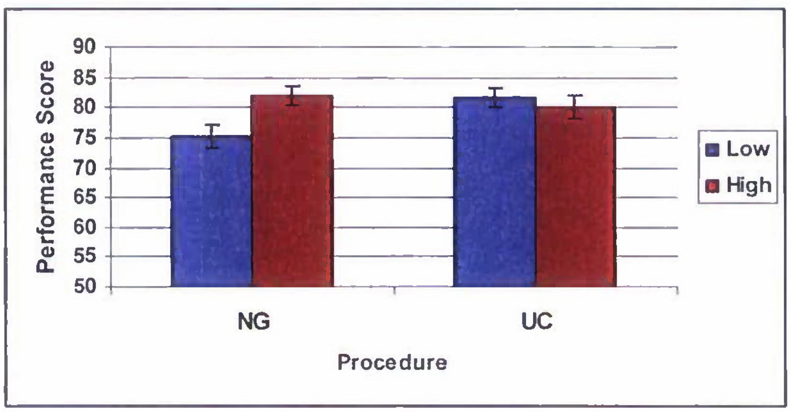


Figure 2. Performance Scores for the Low and High Fidelity Mannequin Training Conditions for the NG and UC Procedures

Subscale measures. To continue our investigation on how the fidelity of the training mannequin impacts the nursing procedures being trained, we examined the subskill scores for the NG and UC evaluation instruments. Scores from the five subskills comprising the NG assessment instrument were subjected to a MANOVA with fidelity as the independent variable. A significant multivariate effect was revealed for fidelity, $F(5, 48) = 3.09$, $p < .02$, and from Fig. 3 we can see that for every subskill performance was higher when training was performed with the high than low fidelity mannequin. The between-subject tests for the individual subskill scores showed that the primary source of the multivariate effect was derived from tube insertion, $F(1, 54) = 8.71$, $p < .01$, and verification of placement and securing of tube, $F(1, 54) = 13.71$, $p < .01$. In other words, it was these two subskills of the NG procedure that were most facilitated by training with the high fidelity mannequin.

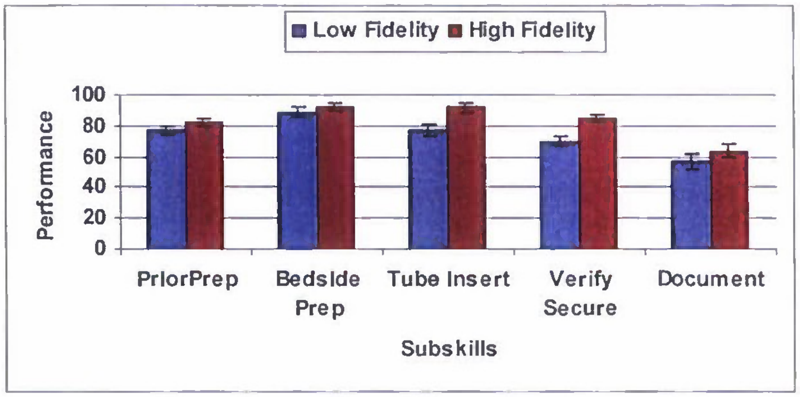


Figure 3. Subskill Scores for the Low and High Fidelity Mannequin Training Conditions for the NG Procedure

When a similar MANOVA was computed for the scores from the six subskills comprising the UC evaluation instrument, no multivariate effect for fidelity was observed and no individual subscales scores proved significant either. The means for this analysis can be found in Fig. 4. The result of this analysis mirrors the nonsignificant fidelity effect for the overall UC procedure score.

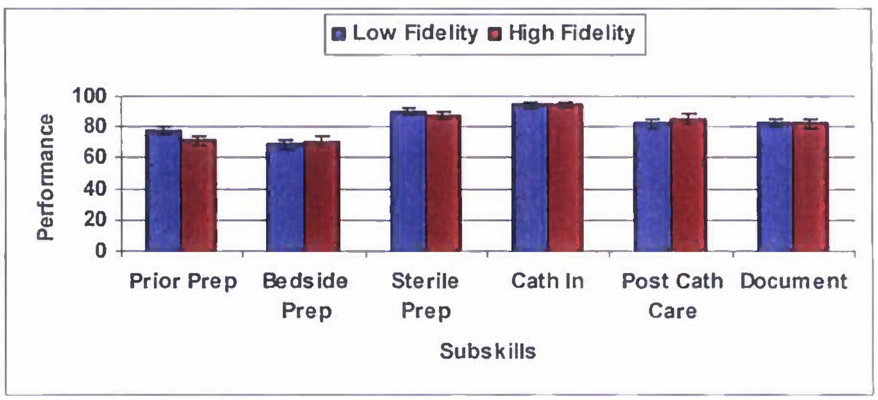


Figure 4. Subskill Scores for the Low and High Fidelity Mannequin Training Conditions for the UC Procedure

Self-report Instrument Results

Post Training Instrument. Paralleling the evaluation of the performance data, we subjected the self-report data collected following the NG and UC training to a within-subjects ANOVA averaging over nursing procedures to contrast low versus high fidelity mannequin levels for each of the eight post-training self-report items. Only one contrast for the item "confidence to perform this procedure on a real patient without supervision" was significant, $F(1, 51) = 9.08$, $p < .01$. As expected participants reported higher confidence when using the high fidelity ($M = 3.48$) than low fidelity ($M = 2.98$) mannequin.

To look separately at the two procedures, the post-training self-report data for each of the two procedures were subjected to a MANOVA with mannequin fidelity as the independent variable. Consistent with the performance results, the MANOVA for NG training returned a significant multivariate effect for fidelity, $F(8, 43) = 5.62$, $p < .01$, indicating that participants who trained with the high fidelity mannequin held more positive attitudes toward the NG training than participants who trained

with the low fidelity mannequin. Inspection of the individual items, depicted in Fig 5, showed that four items accounted for the significant multivariate effect. Participants felt that: the high fidelity mannequin provided more realistic feedback to their actions, $F(1, 50) = 26.39$, $p < .01$; the responsiveness of the high fidelity mannequin helped them learn how to do the procedure, $F(1, 50) = 24.79$, $p < .01$; the high fidelity mannequin increased their motivation to learn, $F(1, 50) = 8.47$, $p < .01$; and working with the high fidelity mannequin improved the whole course experience, $t(50) = 1.54$, $p < .04$, one-tail.

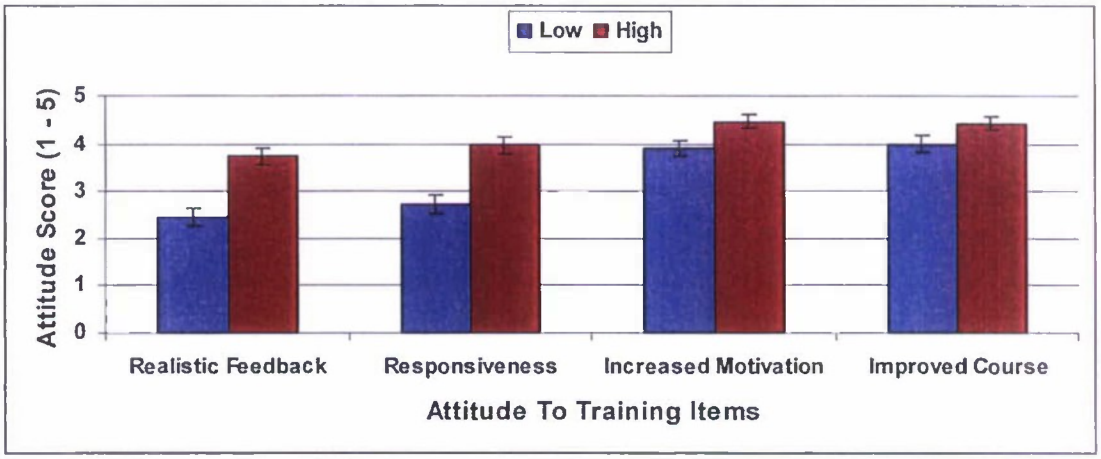


Figure 5. The Four Items of the Attitudes Toward Training Instrument Providing the Principal Support for the Overall Mannequin Fidelity Multivariate Effect for the NG Procedure

Compatible with the lack of performance results reported above for UC, the MANOVA on the post-training items for UC training did not yield a significant multivariate effect, $F \leq 1.0$, ns. There is no difference in attitudes when training with a high versus a low fidelity mannequin for UC skills.

Post Evaluation Instrument. This instrument assessed the participants' perceptions of their test performance, their confidence in their ability to perform the procedure, and their opinions about the training they received. As indicated previously, the items comprising the Post-Evaluation instrument were not intended to assess a single dimension, so each of the 10 items was analyzed separately. As with the post-training items a within-subjects analysis ANOVA averaging over procedures was conducted to contrast low versus high fidelity mannequin levels for each of the 10 post-evaluation items. These within-subjects analyses did not reveal any reliable differences between low and high mannequin fidelity.

Again using mannequin fidelity as the independent variable, a one-way ANOVA was conducted for each item for the NG procedure and for the UC procedure. None of the ANOVAs yielded significant results.

Each of the two post-evaluation questionnaires included an open-ended question asking what was the most difficult part of the procedure. For the NG procedure, the responses were varied. A number of participants mentioned issues related to placement of the tube; others mentioned the difficulty of remembering all the steps in order. The participants' responses did not differ by level of mannequin fidelity used in training.

For the UC procedure, over 60 percent of the student mentioned difficulties associated with maintaining a sterile field. This consensus about the difficulty aspect was most striking in the low fidelity training condition in which 74 percent of the 26 participants offered this response. (In the high fidelity mannequin group, 55 percent of the 22 participants gave this response). This aspect of the UC procedure was partially captured in one of the subscales of the performance instrument: sterile field

preparation. It is interesting to note, as shown in Fig 4, that despite their concern, performance on this aspect of the procedure was quite high, and there was no difference between the low- and high-fidelity groups.

Final Examination. As part of this study, we planned to examine the impact of mannequin fidelity on relevant components of final examination. However, the students' scores on the relevant items were uniformly high (mean scores > 90%.) creating a ceiling effect, with insufficient variance to conduct a meaningful analysis.

Discussion

Performance Results

One of the goals of this study was to replicate the Grady et al. (in press) findings that high fidelity mannequins offer superior training outcomes when compared to low fidelity mannequins. The results replicated the Grady et al. (in press) findings, but only for the female component of the sample. In contrast, the Grady et al. (in press) findings were based on the whole sample, and the advantage of the high fidelity mannequins was even stronger for males than females. The differing results for the males in the two samples may have more to do with the small number of males present in the samples than any real interaction with mannequin fidelity. There were only about a dozen male participants in each sample.

The separate analyses of the individual procedures suggests the benefits of the high-fidelity mannequin may not accrue equally across procedures. The present results show that the training of the NG procedure was positively and significantly impacted by a high fidelity mannequin, but this was not so for training of the UC procedure. Moreover, it was the specific subskills of tube insertion and verification of placement and securing of tube within the NG procedure that benefited most from training with the high fidelity mannequin. We would like to argue that these two subskills are dynamic in nature and thus are supported by the reactivity/responsiveness of the high fidelity mannequin, but then we are hard pressed to explain the lack of effect with the corresponding UC subskills, catheter insertion and post-catheter care. At this point we can conclude that all basic nursing procedures, and more specifically the requisite subskills comprising a procedure, will not benefit equally from training with high fidelity mannequins. More research on particular procedures is needed to better understand the benefits of a high-fidelity mannequin.

Self Report Results

The performance results indicating that the advantages of training with a high fidelity mannequin accrue for the NG procedure but not the UC procedure are reflected in the participants' perceptions of the effectiveness of training. We can speculate that in the NG procedure the 'ouch' and gurgling that the high fidelity mannequin provides is useful feedback to the students about tube placement, which is one of the concerns the participants expressed in the open-ended question on the post-evaluation questionnaire. The results for the UC procedure are somewhat surprising in that the high-fidelity mannequin does provide "urine" when the tube is correctly placed. However, the students were clearly more focused on the difficulty of maintaining a sterile field, and the high fidelity mannequin provides no specific advantage in that respect (except maybe for motivation).

Limitations

One limitation imposed by doing this study in the context of ongoing classroom education is that we were not able to counter-balance the order of the NG and UC training. The students do the NG training first, so it is possible that there is an order effect here that produced the significant NG results and/or lack of results for the UC procedure.

The small male sample size imposes a difficulty in the interpretation of gender results, and specifically why the males showed an advantage under the high-fidelity mannequin in the Grady et al. (in press) study, but not the present one. Additional research with a larger sample of male participants is needed to clarify this question..

Finally, we note that this study only addressed performance closely following training. Studies have shown that participation in experiential learning improves the ease of transition of beginning nursing students into their first clinical rotation (Ham & O'Rourke, 2004). Peteani (2004) cites evidence that students exhibit increased autonomy and self-confidence when delivering patient care after practicing with a high-fidelity simulator. Participants in the present study reported feeling more *confident* in their ability to perform the procedure on a real patient without supervision when they trained under a high fidelity mannequin. But is there any evidence that those who train with a high fidelity mannequin are more *proficient* at doing the insertion on a real patient? Addressing this question requires follow-up when the students begin their first post-training clinical rotation in which they are performing these procedures. Because other factors may intervene, it would be most useful if these students could be followed as soon as possible after the training.

Conclusions

The question of when, and under what conditions, a high-fidelity mannequin is advantageous over a low-fidelity mannequin has implications in nursing departments for decisions about whether to allocate resources for the purchase of high fidelity mannequins and, if they are available, in what aspects of the nursing curriculum they are most advantageous. The partial replication of the Grady et al. (in press) study lends further credibility to positive training effects of high fidelity mannequins and justifies to some extent the extra cost of such training mannequins. The finding that the advantage accrued to one basic skill (NG) but not another (UC) suggests the need to clarify for which basic skills the use of a high-fidelity mannequin is most advantageous. It may also be that the advantages of training with a high-fidelity mannequin are more significant for training complex skills rather than basic ones. We are addressing this question in our current research.

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The Impact of Mannequin Simulator Fidelity on the Learning of Basic Nursing Procedures

Analysis Report

Introduction

Background

Simulation-based experiential learning programs offer great training promise across a variety of educational domains and contexts. In health care, simulation has been used for both formal and clinical education (e.g., Gaba, Howard, & Fish, 2001; Gordon, Wilkerson, Shaffer, & Armstrong, 2001; Marshall, Smith, Gorman, Krummel, Haluck, & Cooley, 2001; Yaeger, Halamek, Coyle, Murphy, Anderson, Boye, Braccia, McAuley, & DeSandre, 2004), and offers a realistic hands-on medium for acquiring basic skills. A large number of schools and training organizations are presently using simulation-based training to complement their classroom pedagogy (Eder-Van Hook, 2005; Kapur & Steadman, 1998).

Emerging evidence that simulation-based training enhances performance leads to a question about the level of simulator fidelity that is required to maximize training effectiveness. High-fidelity simulators are more life-like, and react to inputs in a realistic way, potentially leading to strong educational benefits. In contrast, low-fidelity mannequins capture basic anatomical structure, but they do not mimic any of the physiological and behavioral reactions that a real patient would exhibit and a high-

fidelity mannequin can produce. A review by Issenberg, McGaghie, Petrusa, Gordon, & Scalese (2005) suggests that high-fidelity feedback that accurately mimics realistic human dynamics is one of the primary simulator components that promotes pedagogical effectiveness.

But utilizing reactive simulation invokes a nontrivial financial impact on resources for developing and maintaining training programs. High-fidelity mannequins are more expensive than low-fidelity ones, are more costly to maintain, and are more difficult to move around. Moreover, a time-consuming and extensive faculty commitment is required to operate and maintain high-fidelity mannequins. To justify the extra financial cost and other resources that high-fidelity mannequins require, it is prudent, if not necessary, to have evidence that they provide better training than traditional methods using low-fidelity mannequins.

Grady et al. (in press) addressed the question of whether learning entry level nursing procedures using high-fidelity reactive mannequin is superior to learning with a low-fidelity mannequin. The authors hypothesized that training supported by a reactive mannequin simulator that provides a better analog to the real world will produce a better training milieu and eventuate in higher performance than training supported by the legacy static mannequin that does not provide as close an analog to real-world experiences. They examined the impact of high- versus low-fidelity mannequin levels on the learning of two common nursing procedures: nasogastric tube insertion (NG) and indwelling urinary catheter insertion (UC). They found that training with a high-fidelity mannequin resulted in significantly higher performance than training with a low-fidelity mannequin, and that participants expressed more positive attitudes toward the high- than the low-fidelity mannequin, especially relative to its realism and responsiveness. The study also examined the impact of gender on the acceptance of simulation-based training technologies. Results indicated that males were more positively disposed to training under the high-fidelity mannequin, and benefited from training in that condition more than did the female participants.

Study Objectives

Grady et al. (in press) reported a significant effect of training under a high versus low fidelity mannequin, but the effect size was small and the interaction between mannequin fidelity and gender was only marginally significant. The present study was in part designed to ascertain whether the Grady et al. (in press) results could be replicated. The study was also designed to explore in greater depth how mannequin fidelity impacted each of the nursing procedures being trained. Although in general the design and procedure followed in the present study were similar to that used in Grady et al. (in press), we changed several aspects of the procedure and measurement in order to strengthen the study design, sharpen the measurement instruments, and develop measures of subskills for each procedure to learn whether all aspects of the procedure are equally affected by mannequin fidelity or whether some aspects benefit more from mannequin fidelity than others.

The first change from Grady et al. (in press) was to develop a more fine-grained evaluation instrument used by subject-matter expert observers to assess performance on each of the nursing procedures. To accomplish this, the skills involved in each procedure were decomposed into discrete actions, each of which was assessed as properly performed or not properly performed. Further, for each procedure, the actions were grouped into subcomponents of the overall procedure. In contrast, the evaluation instrument used in Grady et al. (in press) included a smaller number of more global items, each assessing an aspect of the procedure. Performance on each item was evaluated using a Likert-type scale. By decomposing the skills down into finer-grained steps, we felt we would be able to more precisely pinpoint the impact of any differences that occurred in training under a low versus a high fidelity mannequin.

A second change involved practice. A number of participants in the Grady et al. (in press) study mentioned on the post evaluation questionnaire that they would have liked more opportunity to practice the skill on the mannequin than was available in the class period in which it was trained. In the present study, participants were afforded the opportunity to practice the skill (using the same level of mannequin on which they were trained) at a designated time. The opportunity to practice the skill strengthened any differences that might occur in training under the two different types of mannequins.

Finally, in the Grady et al (in press) study, the evaluation for both skills was done during the final exam period. In this study, the evaluations for the two skills were conducted at separate times, closer to when they were trained.

In addition, we also wanted to examine whether mannequin fidelity level impacted participants' knowledge about the procedures as reflected in their scores on relevant skill-oriented questions items in the final exam. (For example, in the NG procedure, what is the appropriate action to take if the patient gasps, coughs, or does not respond vocally to questions when the nurse is inserting the tube?) Although as a written test, the final exam necessarily assessed knowledge (what to do) rather than skill (how to do it), we hypothesized that the more lifelike aspects of the high-fidelity mannequin may have motivated better retention of knowledge. This would be consistent with the Alinier and colleagues' (2006) findings that students who received supplementary scenario-based training using an intermediate fidelity had higher scores on the Objective Structured Clinical Examination than students who followed the normal curriculum.

Method

Participants

The participants in this study were students from first year nursing education classes who signed the consent form. A sample of 54 participants, consisting of 43 women and 11 men, was obtained.

Independent Variables and Design

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As in the Grady et al. (in press) study, the second independent variable was the participant's gender.

The students were trained on both procedures as part of the course curriculum. Two experimental conditions were created. A random half of the participants were assigned to an experimental condition in which NG training was performed with a high-fidelity mannequin followed by UC training with a low-fidelity mannequin. The remaining participants experienced a condition in which NG training was

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Table 1. Interrater Reliabilities for the Two Nursing Procedures

NG	**Reliability**	**UC**	**Reliability**
Overall	0.86	Overall	0.88
Subskills		**Subskills**	
Prior to procedure prep	0.89	Prior to procedure prep	0.88
Bedside preparation	0.74	Bedside preparation	0.63
		Sterile field preparation	0.54
Tube insertion	0.47	Catheter insertion	0.80
Verify and secure	0.87	Post catheter care	0.80
Documentation	0.84	Documentation	0.17

For each procedure two self-report instruments described in Grady et al. (in press) were administered. The Post-Training Questionnaire, which assessed attitudes about the mannequin-based skill

training, was completed by all participants at the end of the NG training and again after the UC training. The instrument was comprised of eight items and had a reported reliability coefficient of 0.88. The Post-Evaluation Questionnaire, which addressed participants' assessment of their performance on the test, their confidence in their ability to perform the procedure, and their opinions about the training they received, was completed after the test on the NG procedure and again after the test for the UC procedure. Because the Post-Evaluation Questionnaire assessed multiple factors, positive intercorrelations among the items were not expected; thus, Coefficient Alpha reliability was not computed.

Procedure

As part of their introductory nursing course participants were trained on the NG procedure and several weeks later the UC procedure. The training was done as part of the regular classroom/lab curriculum and all participants were afforded some hands-on experience. At the completion of each training period participants completed the Post-Training Questionnaire.

Following the training, but prior to testing, practice sessions were schedule in which the participants had the opportunity to practice the nursing procedure using the type of mannequin appropriate to their group and nursing procedure. For each procedure, participants were tested within four weeks after training. (Testing on the NG procedure was done as part of the midterm examination. Testing on the UC procedure was done as part of the final exam.) All testing was completed using high fidelity mannequins. The assessment for each participant lasted approximately 30 minutes.

At testing time a participant entered a testing station and was instructed to perform the targeted nursing procedures. Two subject matter expert (SME) observers were present at the station and each independently evaluated the participant's performance using the observational assessment instrument. At the conclusion of testing the participant completed the Post-Evaluation Questionnaire. At the conclusion of the course participants were debriefed as to the nature of the experiment.

Results

Performance Results

mannequin resulted in higher performance scores was replicated for the female component of the Overall Measures: One purpose of this study was to see if we could replicate the Grady et al. (in press) findings of a main effect due to fidelity and a gender by fidelity interaction. A comparable analysis for the present study is summarized in Fig. 1. The gender (2) X fidelity (2) mixed ANOVA failed to reveal any significant main effects or interaction, $Fs \leq 1.0$, ns. Initially, then, the results of this study do not appear to replicate the Grady et al. (in press) findings. However, inspection of the means pattern in Fig. 1 indicates that the fidelity effect is present for the women but not for the men in the sample. A one-way ANOVA for mannequin fidelity for only the women in the sample showed that women who trained with the high fidelity mannequin ($M = 82.49$) outperformed those who trained with the low fidelity mannequin ($M = 78.14$, $F(1, 40) = 4.28$, $p < .05$). No such effect was present for the men. Thus, in this study the finding reported by Grady et al. (in press) that training with a high fidelity reactive sample. This result is in contrast to the Grady et al (in press) study, where the advantage of the high-fidelity mannequin was stronger for the males than the females. The implications of these results will be taken up in the next section in more detail. Moreover, because a significant gender effect was not found it was dropped as an independent variable in all subsequent contrasts.

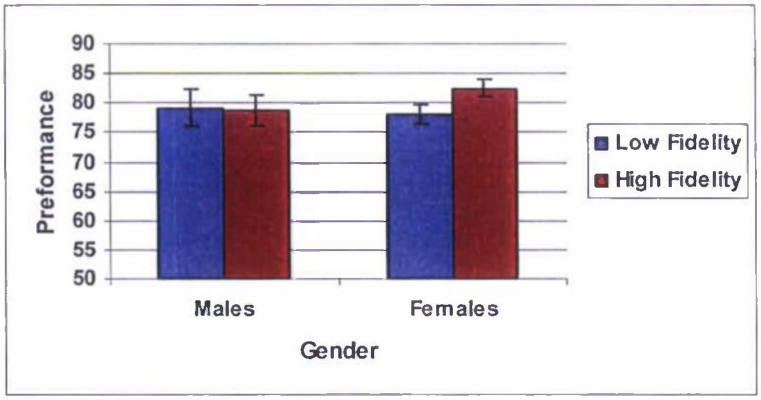

Figure 1. Performance Scores the Low and High Fidelity Mannequin Training Conditions for Male and Female Participants

A second purpose of the present study was to look more closely at how training mannequin fidelity impacted performance on each of the two procedures. For this, 1-way between-subjects ANOVAs were computed for the NG and UC procedures. As Fig. 2 shows, for the NG procedure participants who trained with the high fidelity mannequin earned higher test scores than those who trained with the low fidelity mannequin, $F(1, 52) = 7.44$, $p < .01$. The same analysis for the UC procedure, also depicted in Fig. 2, failed to yield significant results ($F \leq 1.0$, n.s). Thus, there is evidence that the fidelity of the mannequin did not impact the participants' training on the two procedures in the same way.

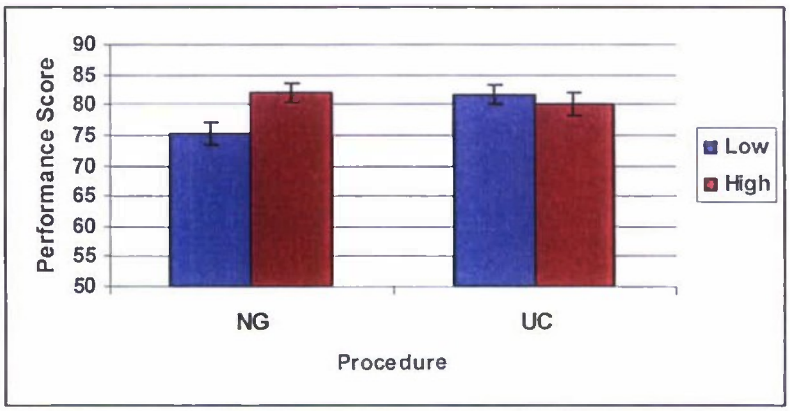

Figure 2. Performance Scores for the Low and High Fidelity Mannequin Training Conditions for the NG and UC Procedures

<u>Subscale measures.</u> To continue our investigation on how the fidelity of the training mannequin impacts the nursing procedures being trained, we examined the subskill scores for the NG and UC evaluation instruments. Scores from the five subskills comprising the NG assessment instrument were subjected to a MANOVA with fidelity as the independent variable. A significant multivariate effect was revealed for fidelity, $F(5, 48) = 3.09$, $p < .02$, and from Fig. 3 we can see that for every subskill performance was higher when training was performed with the high than low fidelity mannequin. The between-subject tests for the individual subskill scores showed that the primary source of the multivariate effect was derived from tube insertion, $F(1, 54) = 8.71$, $p < .01$, and verification of placement and securing of tube, $F(1, 54) = 13.71$, $p < .01$. In other words, it was these two subskills of the NG procedure that were most facilitated by training with the high fidelity mannequin.

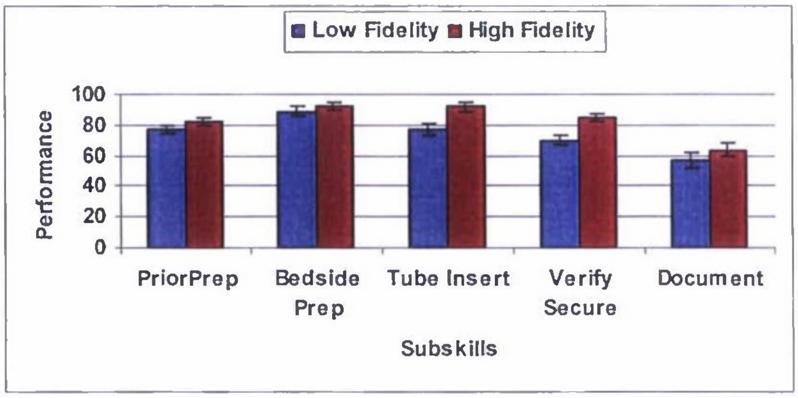

Figure 3. Subskill Scores for the Low and High Fidelity Mannequin Training Conditions for the NG Procedure

When a similar MANOVA was computed for the scores from the six subskills comprising the UC evaluation instrument, no multivariate effect for fidelity was observed and no individual subscales scores proved significant either. The means for this analysis can be found in Fig. 4. The result of this analysis mirrors the nonsignificant fidelity effect for the overall UC procedure score.

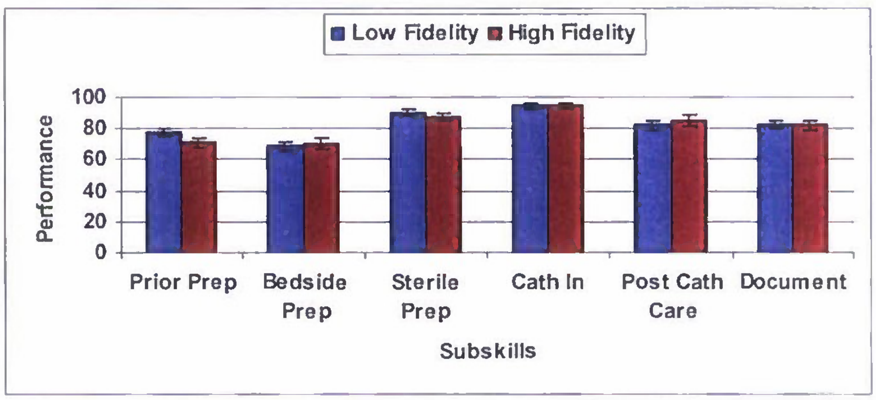

Figure 4. Subskill Scores for the Low and High Fidelity Mannequin Training Conditions for the UC Procedure

Self-report Instrument Results

Post Training Instrument. Paralleling the evaluation of the performance data, we subjected the self-report data collected following the NG and UC training to a within-subjects ANOVA averaging over nursing procedures to contrast low versus high fidelity mannequin levels for each of the eight post-training self-report items. Only one contrast for the item "confidence to perform this procedure on a real patient without supervision" was significant, $F(1, 51) = 9.08$, $p < .01$. As expected participants reported higher confidence when using the high fidelity ($M = 3.48$) than low fidelity ($M = 2.98$) mannequin.

To look separately at the two procedures, the post-training self-report data for each of the two procedures were subjected to a MANOVA with mannequin fidelity as the independent variable. Consistent with the performance results, the MANOVA for NG training returned a significant multivariate effect for fidelity, $F(8, 43) = 5.62$, $p < .01$, indicating that participants who trained with the high fidelity mannequin held more positive attitudes toward the NG training than participants who trained

with the low fidelity mannequin. Inspection of the individual items, depicted in Fig 5, showed that four items accounted for the significant multivariate effect. Participants felt that: the high fidelity mannequin provided more realistic feedback to their actions, $F(1, 50) = 26.39$, $p < .01$; the responsiveness of the high fidelity mannequin helped them learn how to do the procedure, $F(1, 50) = 24.79$, $p < .01$; the high fidelity mannequin increased their motivation to learn, $F(1, 50) = 8.47$, $p < .01$; and working with the high fidelity mannequin improved the whole course experience, $t(50) = 1.54$, $p < .04$, one-tail.

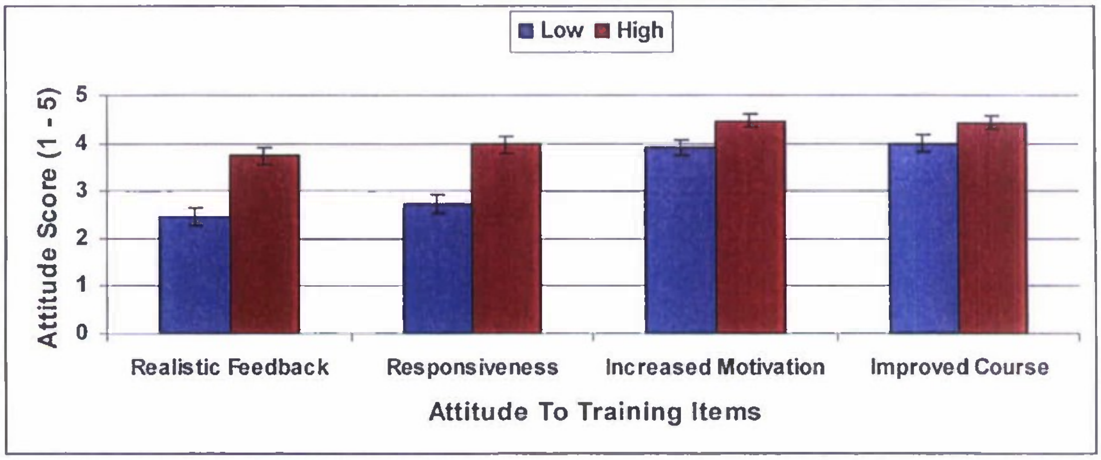

Figure 5. The Four Items of the Attitudes Toward Training Instrument Providing the Principal Support for the Overall Mannequin Fidelity Multivariate Effect for the NG Procedure

Compatible with the lack of performance results reported above for UC, the MANOVA on the post-training items for UC training did not yield a significant multivariate effect, $F \leq 1.0$, ns. There is no difference in attitudes when training with a high versus a low fidelity mannequin for UC skills.

Post Evaluation Instrument. This instrument assessed the participants' perceptions of their test performance, their confidence in their ability to perform the procedure, and their opinions about the training they received. As indicated previously, the items comprising the Post-Evaluation instrument were not intended to assess a single dimension, so each of the 10 items was analyzed separately. As with the post-training items a within-subjects analysis ANOVA averaging over procedures was conducted to contrast low versus high fidelity mannequin levels for each of the 10 post-evaluation items. These within-subjects analyses did not reveal any reliable differences between low and high mannequin fidelity.

Again using mannequin fidelity as the independent variable, a one-way ANOVA was conducted for each item for the NG procedure and for the UC procedure. None of the ANOVAs yielded significant results.

Each of the two post-evaluation questionnaires included an open-ended question asking what was the most difficult part of the procedure. For the NG procedure, the responses were varied. A number of participants mentioned issues related to placement of the tube; others mentioned the difficulty of remembering all the steps in order. The participants' responses did not differ by level of mannequin fidelity used in training.

For the UC procedure, over 60 percent of the student mentioned difficulties associated with maintaining a sterile field. This consensus about the difficulty aspect was most striking in the low fidelity training condition in which 74 percent of the 26 participants offered this response. (In the high fidelity mannequin group, 55 percent of the 22 participants gave this response). This aspect of the UC procedure was partially captured in one of the subscales of the performance instrument: sterile field

preparation. It is interesting to note, as shown in Fig 4, that despite their concern, performance on this aspect of the procedure was quite high, and there was no difference between the low- and high-fidelity groups.

Final Examination. As part of this study, we planned to examine the impact of mannequin fidelity on relevant components of final examination. However, the students' scores on the relevant items were uniformly high (mean scores > 90%.) creating a ceiling effect, with insufficient variance to conduct a meaningful analysis.

Discussion

Performance Results

One of the goals of this study was to replicate the Grady et al. (in press) findings that high fidelity mannequins offer superior training outcomes when compared to low fidelity mannequins. The results replicated the Grady et al. (in press) findings, but only for the female component of the sample. In contrast, the Grady et al. (in press) findings were based on the whole sample, and the advantage of the high fidelity mannequins was even stronger for males than females. The differing results for the males in the two samples may have more to do with the small number of males present in the samples than any real interaction with mannequin fidelity. There were only about a dozen male participants in each sample.

The separate analyses of the individual procedures suggests the benefits of the high-fidelity mannequin may not accrue equally across procedures. The present results show that the training of the NG procedure was positively and significantly impacted by a high fidelity mannequin, but this was not so for training of the UC procedure. Moreover, it was the specific subskills of tube insertion and verification of placement and securing of tube within the NG procedure that benefited most from training with the high fidelity mannequin. We would like to argue that these two subskills are dynamic in nature and thus are supported by the reactivity/responsiveness of the high fidelity mannequin, but then we are hard pressed to explain the lack of effect with the corresponding UC subskills, catheter insertion and post-catheter care. At this point we can conclude that all basic nursing procedures, and more specifically the requisite subskills comprising a procedure, will not benefit equally from training with high fidelity mannequins. More research on particular procedures is needed to better understand the benefits of a high-fidelity mannequin.

Self Report Results

The performance results indicating that the advantages of training with a high fidelity mannequin accrue for the NG procedure but not the UC procedure are reflected in the participants' perceptions of the effectiveness of training. We can speculate that in the NG procedure the 'ouch' and gurgling that the high fidelity mannequin provides is useful feedback to the students about tube placement, which is one of the concerns the participants expressed in the open-ended question on the post-evaluation questionnaire. The results for the UC procedure are somewhat surprising in that the high-fidelity mannequin does provide "urine" when the tube is correctly placed. However, the students were clearly more focused on the difficulty of maintaining a sterile field, and the high fidelity mannequin provides no specific advantage in that respect (except maybe for motivation).

Limitations

One limitation imposed by doing this study in the context of ongoing classroom education is that we were not able to counter-balance the order of the NG and UC training. The students do the NG training first, so it is possible that there is an order effect here that produced the significant NG results and/or lack of results for the UC procedure.

The small male sample size imposes a difficulty in the interpretation of gender results, and specifically why the males showed an advantage under the high-fidelity mannequin in the Grady et al. (in press) study, but not the present one. Additional research with a larger sample of male participants is needed to clarify this question..

Finally, we note that this study only addressed performance closely following training. Studies have shown that participation in experiential learning improves the ease of transition of beginning nursing students into their first clinical rotation (Ham & O'Rourke, 2004). Peteani (2004) cites evidence that students exhibit increased autonomy and self-confidence when delivering patient care after practicing with a high-fidelity simulator. Participants in the present study reported feeling more *confident* in their ability to perform the procedure on a real patient without supervision when they trained under a high fidelity mannequin. But is there any evidence that those who train with a high fidelity mannequin are more *proficient* at doing the insertion on a real patient? Addressing this question requires follow-up when the students begin their first post-training clinical rotation in which they are performing these procedures. Because other factors may intervene, it would be most useful if these students could be followed as soon as possible after the training.

Conclusions

The question of when, and under what conditions, a high-fidelity mannequin is advantageous over a low-fidelity mannequin has implications in nursing departments for decisions about whether to allocate resources for the purchase of high fidelity mannequins and, if they are available, in what aspects of the nursing curriculum they are most advantageous. The partial replication of the Grady et al. (in press) study lends further credibility to positive training effects of high fidelity mannequins and justifies to some extent the extra cost of such training mannequins. The finding that the advantage accrued to one basic skill (NG) but not another (UC) suggests the need to clarify for which basic skills the use of a high-fidelity mannequin is most advantageous. It may also be that the advantages of training with a high-fidelity mannequin are more significant for training complex skills rather than basic ones. We are addressing this question in our current research.

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Simulation Study # 2

Radiography Simulation Learning Protocol

Background

Simulation has been used for decades by the military, aviation, transportation, and most nuclear power industries. In the United States as well as other countries, organizations have invested heavily in training tools, educational materials, and simulation technology in the last decade. US Departments of Defense, Justice, and Health have expended numerous efforts to examine the best ways to create training simulations, course material, and scenarios that most effectively meet training needs (1). Simulation has been successfully used in the health care education arena as a teaching strategy for clinical and formal education.

Simulator-based education has the potential to positively impact our ability to train students in allied health professional fields, such as Diagnostic Medical Imaging and Radiography. Allied health professionals trained in these fields are technologists who work directly with patients and physicians as

they perform diagnostic testing procedures. Because of their diagnostic utility and relative safety as a diagnostic procedure, these fields are expected to grow significantly over the next decade. To fill the predicted need for qualified allied health care providers, efficient and cost-effective methods are needed to train these professionals.

According to the Bureau of Labor Statistics, employment of radiology technologists is predicted to grow faster than average between 2006 to 2016 (2). The general population is aging and the demand for diagnostic imaging is increasing. As the population changes so does the profession. The field of medical imaging is evolving technologically due to the advancement of computers which has prompted traditional imaging to become digital. Images are archived and sent to networked facilities via a Picture Archiving and Communication System (PACS). PACS and digital imaging has recently been implemented into the national registry exam for radiologic technologists but little information has been found pertaining to medical imaging students' education in PACS for digital imaging. The American Society of Radiologic Technologists (ASRT) Radiology Curriculum suggests that digital imaging acquisition and display be a key content area and for programs to provide an understanding of the components and principles of digital imaging systems (3). The curriculum also recommends students understand the basics of digital imaging systems, digital image display, architecture of PACS, teleradiography, post-processing capabilities, and display monitors.

Demands on health care providers and medical educators to improve patient safety and care have increased. The concept of 'learning by doing" has become less acceptable. Technology can provide alternative methods to gain procedural experience. Web-based education, virtual reality and high-fidelity human patient simulation are examples of state-of-the-art approaches to educating students in health related fields (4).

Largely delivered using the traditional classroom format, digital imaging education for allied health students has depended on the availability of appropriate equipment for practice in the actual clinical settings, which may or may not be available to students in all geographic locations. Technological advances in equipment have provided additional tools for educators, but the literature is lacking in evidence-based, best practice approaches to training techniques using advanced educational technologies in the classroom setting.

Although there is paucity in the literature addressing best practices in the use of technology, the Health Care Industry Advisory Council and the American Society of Radiologic Technologists have joined forces to establish best practices and recommendations for improving new skills acquisition for radiologic technologists. One area that was addressed is to enhance the entry-level radiologic technologist educational process to prepare individuals for the influence of technology and the importance of life long learning. A technologist's initial education is key to later skills acquisition and commitment to life long learning. The primary education also forms the core skills needed to grasp the concepts on which new technologies are based. The International Society of Radiographers and Radiological Technologists views entry-level education as a starting point in its educational program guidelines (5).

Several challenges in today's health care community have promulgated the need for cost-effective and efficient innovative strategies that teach radiography students about real world radiography in a simulated environment. The capacity to train new staff to meet the needs of health care organizations is diminishing while greater public concern for patient safety exists. Increased patient acuity, shorter patient hospital stays, and an increasingly complex clinical environment with increased use of technology are situations that require adequately prepared radiographers. Radiography faculty shortages and a growing increase in the required knowledge base are other factors impacting future radiography preparation. Ill-prepared radiographers face fast-paced practice settings, heavy workloads, and limited supervision. It is imperative, therefore, that radiographers new to the workforce are confident, competent, and develop good clinical thinking skills. A health care professional's ability to react prudently in an unexpected

situation is a critical factor for positive outcomes to result. This ability is learned and developed over time with training, practice, and repetition.

Radiography education is very similar to that of nursing education in which clinical simulation represents a revolutionary technique in which students practice patient positioning on manikins. Simulation is defined as a teaching method in which learners practice tasks and processes in real- world type circumstances using models or virtual reality with feedback from instructors and peers (6). It is believed that the role of practice in the mastery of a skill is essential while attempting to learn a skill and, after initially learning it, in the retention to maintain proficiency (7). While simulation might be applicable to image interpretation fields like radiology, personnel can often train using archived images of real patients (8).

Currently, there are limited simulation devices available in radiography. Simulation software focusing on PACS, computed radiography, and virtual positioning are obtainable. Computer simulation attempts to reproduce real-life situations and asks the student to provide data that may alter the outcome of the procedure. In the health professions, allowing a student to attempt patient care without "experimenting" on actual patients is ideal. Simulations can bridge the gap from abstract knowledge presented in class to actual performance by letting the student learn the difference between good and poor decisions in patient care. Simulations also can bring about higher-order synthesis and analysis skills (9).

The use of computerized simulation software and manikins provides a safe learning environment that allows students to become better equipped to handle a variety of circumstances without jeopardizing real patients. Situations that students may never encounter in their clinical rotations can be "simulated" in the lab where faculty can allow students to make mistakes and see the consequences of their errors. Students can not only learn positioning skills and practice utilizing the PACS and workstation, but also build confidence in their own critical thinking and decision making skills without causing discomfort or danger to real patients. The use of equipment and software can be a viable educational tool to teach multiple skills related to anatomy/pathology, image quality, patient positioning, etc. Computer skills are considered mandatory for today's radiologic technologists, and digital imaging skills have been identified as among the most important skills for these allied health professionals, regardless of geographic location (10). As with the education of all health care providers, patient safety, the reduction of medical errors, and improving department efficiency by embracing current and new technologies will continue to drive the development of educational strategies.

Technology-centric learning environments with simulation software and PACS may enable the best possible learning experience for radiography students. Schools of radiography and other academic institutions need to develop, implement, and evaluate simulation used for teaching strategies for best practices in education. The Medical Imaging and Radiation Sciences Department at Mount Aloysius College in west-central Pennsylvania will conduct a research study to investigate the effectiveness of simulation compared to traditional techniques.

Research Design and Methods

Design

The study is designed to determine if simulation-based learning is more effective than traditional methods. This is a prospective, experimental study with two intervention groups using a post-only control For this design order is nested within the original factor, training type, to produce four experimental conditions. At one nested level of training type, students experience training module one using the radiology simulation environment and, when that training is complete, experience training module two using the legacy training procedure. In contrast, at nested level two, students experience training module one using the legacy training procedure and, when that training is complete, experience training module two using the radiology simulator. Thus each student in the study has experience with

the radiology simulation environment and the legacy training procedure. For the analysis, collapsing over training modules we can compare each student's performance with the radiology simulation environment to his or her performance with the legacy procedure as a within-subjects analysis. Within-subjects analyses are more powerful (i.e., able to detect smaller differences) as each student serves as his or her own control.

The study will attempt to answer the following research questions:

- Is simulation-based training more effective than traditional method?
    i. For positioning?
    ii. For analysis and interpretation?
- Are students satisfied with this method of learning?
- Are faculty members satisfied with this method of teaching?

We hypothesize that the simulation/PACS-based training will be more effective than the traditional (legacy) training for both patient positioning and film interpretation

Intervention

A training protocol will be developed for the testing of two skills: procedure and interpretation. Students will be assigned to one of two groups depending upon the laboratory section in which they enroll. During the first half of the semester, students in Group I will be taught procedures and film interpretation using simulation software and the PACS. Group II students will be instructed in procedures and interpretation using the legacy training method. Testing for procedures and film interpretation will occur following the training at or prior to the midpoint of the class.

In the second half of the semester, Group 1 students will be taught procedures and film interpretation using the legacy training method while Group 2 students will be taught procedures and film interpretation using the simulation software and PACS. Testing for procedures and film interpretation will occur during the last half of the semester prior to the final exam.

Testing

Testing will occur during the semester. Students in both groups will receive the same exams. There will be two testing components: a written exam and laboratory simulation. The written exams on the content discussed in class will be completed by students in both groups. (Appendix A). The written exam will have questions pertaining to positioning (procedure), anatomy, and film critique (interpretation). During the week of the written exam, each student in the class will make an appointment with instructor and/or a subject matter expert (SME) to simulate a procedure or part of a procedure utilizing using the manikin and the radiography equipment in the laboratory. The SME and/or instructor can randomly select what part or all of the procedure is to be performed in order to counteract any information passed on by those who have been tested to those who have not that may indicate what section was being tested. The laboratory simulation will be used to evaluate performance (Appendix B). The observation instrument to be used to allow an SME to reliably and validly evaluate the performance of the students as they perform the skills in the laboratory will be the same whether the student is in group 1 or 2.

In addition to the performance measures, four questionnaires will be administered (see Appendix C): 1) a background questionnaire, which will be administered at the start of the study; 2) a questionnaire assessing the students' attitudes and beliefs about the legacy training environment, which will be administered after the students complete the component of the course in which they experience the legacy

system; 3) a questionnaire assessing the students' attitudes and beliefs about the simulation software and the PACS, which will be completed after that segment of the course in which the students experience the simulation system, and; 4) an end of the study questionnaire comparing the two training approaches.

Data Collection and Statistics

Sample size

Subjects will be recruited from the Radiography 109 laboratory classes scheduled for the spring Semester in 2009. All students attending these labs will be invited to participate. We estimate that the sample of 30-40 students will yield moderate effect sizes (0.4-0.6) and will have moderate power (0.6-0.7).

Statistical Methods

Performance of the radiology simulation training condition will be statistically compared to that of the legacy training. Two performance measures will be computed for each condition (legacy, simulation). The first will be derived from the written exam by summing the number of correct answers. (In addition, subscores may be obtained for positioning and interpretation.) The second will be based on the ratings of student performance in the laboratory simulation. If personnel allows, we strive to have two SMEs rate each student, the two independently completed observer instruments for each student will be compared and large differences (more than 2 scale point difference) in task ratings will be adjudicated. The reliability of raters in terms of coefficient alpha will be computed for each pair of raters across common students. The rating instruments will be summed across tasks to arrive at a total rating or score. The two total rating scores for each student will be averaged to produce the second performance measure.

The two performance measures will each be subjected to a within-subjects ANOVA. Thus, performance means derived from the traditional (legacy) training condition will be contrasted with means derived from the experimental (simulation) training condition. A main effect indicating that the simulation condition means are significantly larger than the traditional (legacy) condition means will provide conformation of the hypothesis. Effect sizes and confidence intervals will also be computed.

We will carry out a similar analysis for the self-report attitudinal scales. A main effect will show more positive attitudes for the experimental training condition.

Data Analysis Overview :

The purpose of this study was to compare the effectiveness and acceptance of two alternative approaches for teaching introductory radiology students about anatomy, positioning, and imaging. In the traditional laboratory approach used at Mt. Aloysius for teaching radiographic technology, the instructor demonstrates positioning and imagery techniques using a manikin and discusses existing radiographic images in terms of anatomy, positioning, and exposure. During the laboratory period, the students are able to practice positioning on the manikin and with each other. Although they can position the radiographic equipment, they do not actually take images. In the PACS/Sim approach, in addition to the archived digital images, the students use the computer-based software to position a simulated patient, and to take and critique radiographic images. The software is available to the students at any time, so they are able to work individually at their own pace and time. We hypothesized that the simulation/PACS-based training, which allows students to take and see their own images, and to repeat that process as many times as they want, would be more effective than the traditional (legacy) training for both patient positioning and film interpretation.

Method

Participants

All students enrolled in "radiology 101" were eligible to participate in the study, and all [but XX] agreed to participate. The initial sample was comprised of 31 participants of whom nine were males and 22 females. Seventy-four percent of the participants were in the18-23 year age range, and only one person was older than 33 years. All but one of the participants were first-year students, and only two had a previous (associates) degree.

Design

There were three laboratory sections for this course. Students in laboratory sections 1 and 3 were assigned to Group 1. Students in laboratory section 2 were assigned to Group 2. During the course, the students studied radiographic procedures for six anatomical areas (or topics): Bony thorax, ribs, scoliosis series; cervical and thoracic spine; lumbar spine, sacrum, coccyx; skull and sinuses; facial and nasal bones; and mandible, temperomandibular joints, zygomatic arches. For the first three topics, students in Group 1 were taught imaging procedures and film interpretation using simulation software and the PACS. Group 2 students were instructed in procedures and interpretation using the legacy training method. For the last three topics, Group 1 students were taught procedures and film interpretation using the legacy training method while Group 2 students were taught procedures and film interpretation using the simulation software and PACS.

Dependent Variables

Four performance measures were assessed at the completion of each of the six topic areas. Three of these (anatomy, positioning, and imaging) were derived from a written test developed by the instructors. The fourth was a simulation test in which the participants were required to conduct a (simulated) radiological exam. The simulation test, which was performed using the manikin as the patient, included items assessing the positioning of the patient, use of the equipment, and completeness of assessment.

Because the number of items on each component of the written test (anatomy positioning, imaging) differed across the topic areas, we converted the scores to percent correct. The a simulation test was graded by the instructor using a specifically designed evaluation instrument comprised of 10 items, each of which was graded on a five-point scale ranging from fail to high pass. For ease of comparison we transformed this to a 100 point scale, which could range from 20 to 100.

To create the dependent variables, we computed the mean score on each of the four measures for the three tests taken using the PACS/Sim software and for the three tests taken using the traditional laboratory approach. Thus, for each participant, we had a total of four dependent measures (anatomy, positioning, imaging, and simulation) derived from tests taken using the PACS/Sim software and four measures taken under the traditional laboratory approach.

We developed four questionnaires for this study: a background questionnaire, a questionnaire assessing the students' opinions about the PACS/Sim training, a questionnaire assessing the students' opinions about the traditional (legacy) training, and a questionnaire comparing the two training approaches.

Procedure:

At the outset of the course, the students completed the background questionnaire. Testing for procedures and film interpretation on each of the six topics occurred after training on that topic. At the end of each phase of training (i.e., after training on the third topic, when the two groups switched training method) and at the end of the course (i.e., after training on the last topic), the students completed the questionnaire

assessing their views about the effectiveness of the training methodology they had just used. At the end of the course, they completed the questionnaire in which they were asked to compare the two approaches on a number of dimensions.

Results

Performance Assessment

We used a within-subjects analysis to compare performance under the PACS/Sim and traditional laboratory approaches. Figures 1 through 3 show the comparison between the two approaches for the three components of the written test – anatomy, positioning, and imaging. There were no differences in the mean anatomy or positioning scores under the two conditions, but the mean imaging score under the traditional laboratory condition was significantly higher than those under the PACS/Sim condition ($F(1,29) = 5.37$, $P<.03$, eta sq = .16). The mean simulation test scores are shown in Fig. 4. Analysis showed a marginally significant difference between the two training approaches ($F(1,29) = 4.09$, $P<.06$, eta sq. = .12) in favor of the traditional laboratory condition.

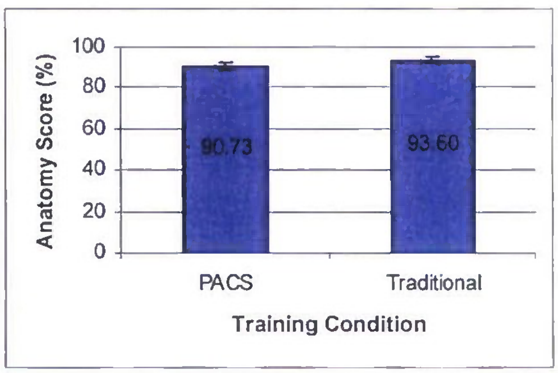

Figure 1. Comparison between two training conditions on Anatomy Score.

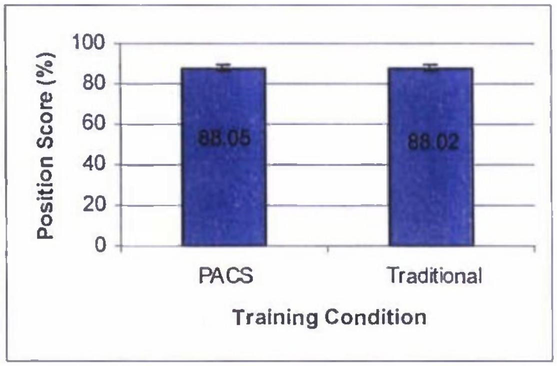

Figure 2. Comparison between two training conditions on Positioning Score

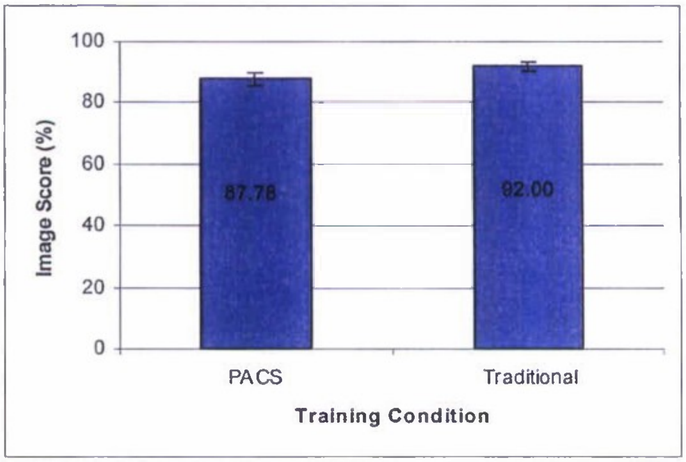

Figure 3. Comparison between two training conditions on Imaging Score

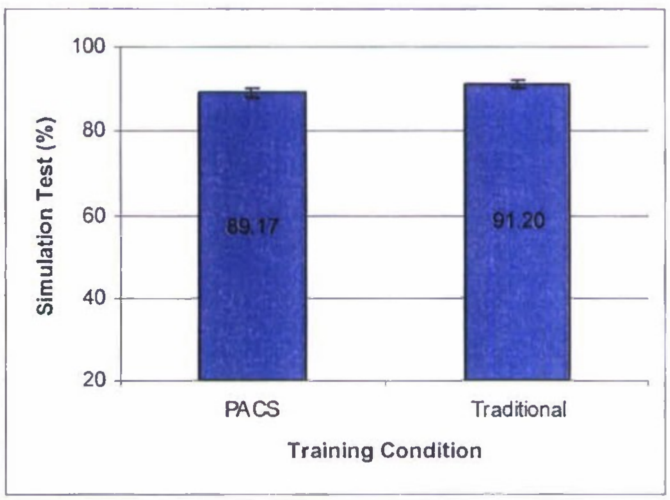

Figure 4. Comparison between two training conditions on Simulation Score.

Attitudes towards the Two Training Approaches

Learning mode preference

In the background questionnaire we asked the participants to rank their preferences for five alternative learning modes: listening, visualizing, discussing, doing, and reading. The minimum, maximum and mean ranking for each of the five modes are shown in Table 1, with 1 being the most preferred and 5 the least preferred mode. As the table indicates, the participants have a clear preference for learning by doing. The mean ranking was 1.47; two-thirds of the participants ranked this as their most preferred mode. Learning by reading is clearly the least preferred alternative: The mean ranking was 4.29; two-thirds ranked learning by reading as their least preferred mode.

Table 1. Participants' preferences for learning mode

mode	Minimum rank	Maximum rank	Mean rank	Std deviation
Listening	2	5	3.63	0.93
Visualizing	1	5	2.34	1.18
Discussing	1	4	3.18	0.80
Doing	1	4	1.47	0.81
Reading	1	5	4.29	1.27

There were no differences between the participants who started with PACS/Sim and those who started using the traditional laboratory on their learning preferences or on any of the background questions.

Participants' assessment of training approaches

At the midpoint and end of the course, the students completed a questionnaire asking their opinions about the training approach they had just experienced. Using a similar within-subjects analysis as was done for the performance scores, we compared the participants' assessment of the PACS/Sim to the traditional laboratory condition. Students responded to the items on each questionnaire using a 5-point Likert type scale, where 1 reflected a negative rating and 5 a positive rating. The items were grouped into four categories: training quality, usefulness of the laboratory period, radiological skill training effectiveness, and overall evaluation of the training. The mean scores for these four categories are shown in Figures 5, 6, 7, and 8, respectively. As the figures clearly show, there was a strong preference for the traditional

laboratory approach over the PACS/Sim approach. In all cases, the mean rating for the traditional laboratory approach was significantly higher than that for the PACS/Sim approach.

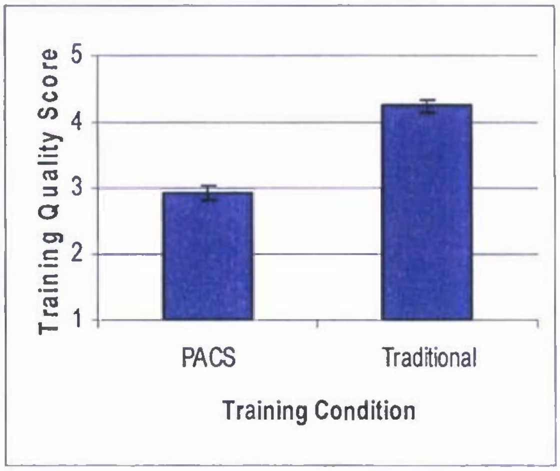

Figure 5. Comparison between two training conditions on Participants' evaluation of quality of training, $F(1, 28) = 86.18$, $p<.01$, effect size =.76

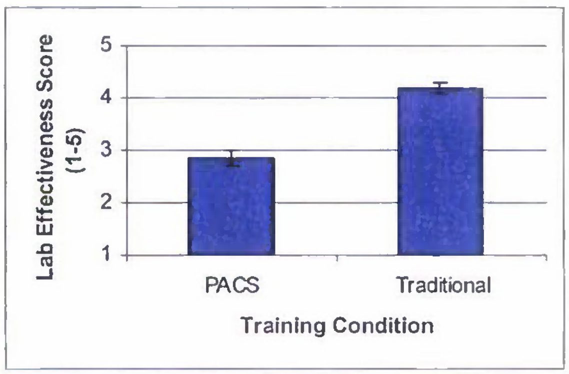

Figure 6. Comparison between two training conditions on Participants' evaluation of laboratory time, $F(1, 28) = 57.54$, $p <.01$, effect size =.67

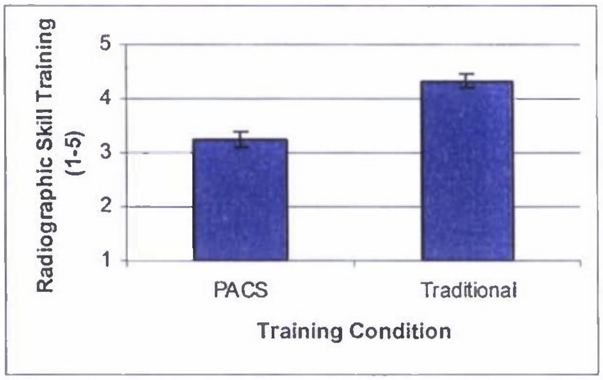

Figure 7. Comparison between two training conditions on Participants' evaluation of radiographic skills, $F(1,28) = 35.21$, $p < .01$, effect size =.56

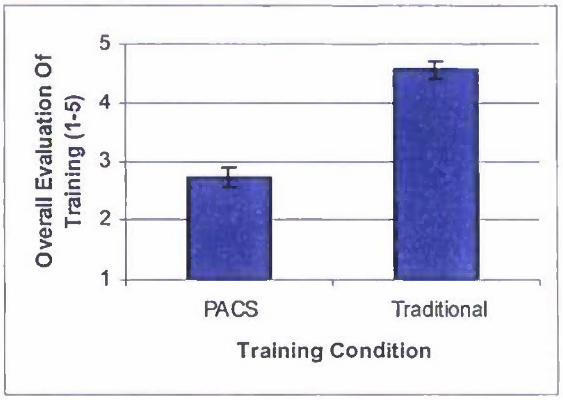

Figure 8. Comparison between two training conditions on participants' overall evaluation, $F(1, 28) = 86.17$, $p < .01$, effect size =.78

The end of study questionnaire asked the students to compare the two approaches on a number of dimensions. We coded the response alternatives from -5 (strong preference for PACS/Sim) to +5 (strong preference for traditional laboratory), with 0 indicating no preference. As shown in Table 2 every mean was positive indicating a mild to strong preference for the laboratory approach. The preference for the traditional laboratory was particularly strong on positioning and practicing. For only two items, recognizing incomplete views in the radiographic images and evaluating films, was the students' preference close to neutral (0).

Table 2. Relative comparison of two training approaches

Measure	Mean	Std error/std dev
Overall preference	4.31	0.14 0.71
Patient positioning	4.60	0.09 0.50
Select appropriate view	2.83	0.41 2.26
Recognize incomplete views	1.43	0.55 3.04
Position in clinical setting	4.60	0.10 0.56
Evaluating films in clinical setting	0.53	0.68 3.71
Increasing confidence in performing procedures competently	2.52	0.53 1.94
Most effective feedback	4.00	0.33 2.87
Best opportunities to practice	4.40	0.20 1.80
Efficient/effective use of time	3.33	0.21 1.13

In the background questionnaire that the participants completed at the outset of the study, we asked the participants two questions about computers and technology: how they would rate their computer skills, and how comfortable they are trying and using new technologies. We hypothesized that those who said they were more proficient with computers or those who embraced new technologies would be more accepting of the PACS/Sim approach. We found no evidence for a negative biased towards computer technology. The majority of the students rated themselves as having good or very good computer skills, and most students claimed they were open to new technologies. Within the restricted range of ratings, we found no relationship between the participants' ratings of their computer skills and their evaluation of the alternative approaches or their comfort with new technology.

The students' responses to several open-ended questions included in the post-study questionnaire illuminate their preference for the traditional laboratory. One comment voiced by a number of students was that they spent too much time learning how to use the simulation software. Another comment was that the software did not provide sufficient flexibility in positioning the patient. But overwhelmingly, the most often voiced comment was that the students wanted hands-on practice on a real patient (each other) or on a manikin that they could directly manipulate and not on a patient image that they manipulated via pushing buttons on a computer keyboard. This is consistent with their preferences for learning by doing (see Table 1).

Discussion

Contrary to our hypothesis that the PACS/Sim training would be superior to the traditional training, we found no difference in the performance on anatomy or positioning under the two conditions, and a significant difference in favor of the traditional laboratory on imaging. In addition, their performance on

the simulation test, which emphasizes positioning, was also stronger in the traditional laboratory condition. Similarly, although we hypothesized that the PACS/Sim software would provide the students with more opportunity to practice positioning the patient, the students strongly preferred to practice on themselves or a manikin. It is possible that this marginally significant difference in favor of the laboratory training on the simulation test can be explained by the fact that the test was performed on the manikin, and thus those who were trained and tested using the same simulation method were at an advantage.

We hypothesized that the PACS/Sim software would offer the students a richer opportunity for learning about imaging because it allows the students to take and then examine an image to see whether it captured the critical anatomical features they were after, and to do this repeatedly until they were satisfied that they had a suitable image. Contrary to our expectation, the results revealed that the students actually performed better with the traditional approach in which the instructor showed and discussed with them stored images taken by someone other than themselves. One possible explanation is that the students learned more from a rich and critical examination of existing images than they were able to derive from the limited feedback provided by the computer (was there any??) about their own images. Even though they were able to see the images they took, they may yet be able to see the flaws and limitations in the image without help from the instructor or a more experienced individual.

At the outset of the study participants said that they most prefer learning by doing, and that preference was consistent with their positive evaluation of the traditional laboratory and was voiced frequently in their responses to open-ended questions about the two approaches. Given that the students felt competent in using computers and were open to new technology, we cannot attribute their negative evaluations of the PACS/Sim approach to an anti-technology bias.

Limitations.

This study was conducted the first time the PACS/Sim technology was used for instruction at Mt. Aloysius, so the results do not provide a definitive comparison of the two approaches. Future students may benefit from improvements in use of the computer technology that instructors can make based on their initial experience, leading to a different pattern of results. A second limitation is that because the study was conducted as part of classroom training, we were not able to counter-balance the two treatments appropriately or randomly assign participants to treatments.

Conclusions

This study evaluated a first attempt to use computer simulation-based technology for teaching radiography. We found that the participants clearly preferred the traditional laboratory experience over the PACS/Sim experience and the performance results showed some support for that preference. Instructors can use experiences derived from this first administration of the class using the PACS/Sim technology to improve the effectiveness and acceptance of the technology. The students' reported difficulty in manipulating the computer-based patient suggests that more initial training in using the software is needed. In the future it may also be useful to evaluate the effectiveness and acceptability of an approach that integrated the two training methodologies.

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Simulation Study # 3

Study Results

A Comparison of Using High Fidelity Simulation vs. Virtual Case Studies in the Acquisition of Complex Clinical Nursing Skills

Background

In nursing education, simulation is an attempt to 'mirror' or replicate aspects of a clinical situation so that the situation can be better managed when it occurs in a real clinical environment. The word fidelity is often used in simulation and is defined as "precision of reproduction." Simulation attempts to achieve a

high enough fidelity to convince the learners that they are using something that resembles what they would encounter in real life (11). Simulations range from the use of case studies to educate students about patient situations or the use of role-playing to engage students in a particular clinical situation. Part task-trainers and low-fidelity simulators are used to help students learn and practice particular clinical skills and intervene with basic changes in patient condition. High-fidelity patient simulators are sophisticated computer simulated manikins that provide a high level of interactivity and realism for the learner (6). Computer-based scenarios enable students to participate in a virtual clinical environment where they focus on assessment, problem solving, skill performance, and decision making during the care of a virtual patient.

High-fidelity simulation experiences represent a teaching strategy in which students develop and practice clinical decision-making and skills on highly sophisticated, realistic manikins. A major advantage of this strategy is that it encompasses the three domains of learning: cognitive, psychomotor and affective (9). The use of simulation provides value to nursing educators because of it allows students to develop interactive critical thinking skills and assessment abilities in a non-threatening environment (10). The use of complex scenarios during the simulation activity allows students to assess changing medical conditions and identify critical incidents. The measurement of physical parameters and communication with the simulated patient enable students to determine appropriate interventions and evaluate the need for further intervention (6).

In contrast, simulation using computer-based virtual clinical environments is an innovative teaching strategy that enables students to engage in a virtual hospital setting where they interact with virtual patients, and access and evaluate realistic information essential for patient care. The virtual activity allows students to make decisions and set priorities within the virtual hospital setting. Students can also develop effective communication, documentation, assessment and critical thinking skills.

Few studies have been published that examine what effect simulation activities have on the attainment and retention of knowledge and on performance on written exams that assess knowledge and the application of critical thinking skills. Of those reported, Katz et al (8) found no different between a group exposed to simulation training and those not exposed to training on clinical instructor ratings of competence in the clinical setting or on the participants' self-assessment of clinical judgment. On the other hand, Childs and Sepples (3) showed that students retain knowledge learned from a simulation for a longer period of time compared to the traditional method of teaching (3), where knowledge is assessed through the use of verbal questioning or written tests.

Even fewer studies have contrasted the effectiveness of differing types of simulation activities on knowledge or performance. Howard (4) compared the use of a human patient simulator (HPS) and an interactive case study approach for the acquisition of knowledge and critical thinking. A Health Education System, Inc (HESI) exam (see http://www.associatedcontent.com/article/35420/hesi_exams_health_education_systems.html?cat=4) was used to measure knowledge and critical thinking ability. Analysis revealed a significant difference with respect to knowledge gained and a marginally significant (p=.051) difference on critical thinking ability on the post-test, with the group using the HPS scoring higher on the post test than the group that used the interactive case study. Johnson et al. (7) compared a HPS to a computer-assisted instruction (CD-ROM) approach and a control group in terms of scores on lower-and higher-level cognition, critical thinking, and

performance standards. Critical thinking was defined as the participants' ability to assess, intervene, and evaluate care of chemical casualty patients, and performance was defined as the ability to assess and implement appropriate care. Results showed that participants in the HPS condition performed significantly better on the higher level cognition, critical thinking, and performance evaluation instruments compared to the CD-ROM and control groups.

Further research is needed to ascertain the effects of varying types of simulation activities on the acquisition and application of knowledge as assessed by written exams. As was done in the previously cited studies, for meaningful evaluation of simulation-based learning, assessment should go beyond factual knowledge, and incorporate measures to assess the student's ability to identify critical incidents, competence with skill performance, communication effectiveness, and implementation of appropriate nursing interventions. (5) The National Council Licensure Examination (NCLEX) incorporates applications of knowledge to multiple categories of patient needs, including effective care management. In terms of Bloom's (1) taxonomy, NCLEX-type questions are written at the application and above level.

The purpose of this study was to contrast training of complex clinical knowledge and skills augmented by interactive computer-based clinical exercises with training augmented by mannequin simulation-based clinical exercises to see which method results in higher scores on a NCLEX-type examination and which method was preferred by the students.

Hypotheses

Given the findings of Howard et al. (4) and Johnson et al. (7), we hypothesize that students utilizing the mannequin-based simulation will have higher scores on an NCLEX-type exam than students utilizing the interactive computer-based virtual simulation.

We have found that nursing students express a preference for hands-on training. For this reason we hypothesize that students will prefer the mannequin simulation over the virtual software simulation for the acquisition of knowledge and application to a complex clinical case. Given the preference for hands-on training, we also hypothesize that students will feel better prepared for the NCLEX and for application of clinical skills to patient care by the mannequin than by the virtual software simulate

Nursing student participant using manikin based simulation

Research Design

Participants

Forty-eight nursing students enrolled in senior seminar classes consented to participate in this study.

Independent Variables

The first of two independent variables was type of training augmentation manipulated over two conditions. The first condition, interactive computer-based virtual exercises (VCE), was developed from commercially available software. The second condition, mannequin-based simulation exercises (MS), was developed using a commercially available high fidelity programmable HPS. The computer-based virtual clinical scenarios were obtained from Evolve/Elsevier's Virtual Clinical Excursion software package[1]; the simulated activity on the mannequin was replicated from the Virtual Clinical Excursion software program.

[1] Permission was obtained from the publisher to use the software program in this study

The second independent variable was medical event (or topic), varied over two events. The events used in this study, which were selected from the Virtual Clinical Excursion software package, included Perioperative Care and DVT/ Pulmonary Embolism. These events are typically covered in upper level seminar/clinical classes, and were judged to be of equal complexity.

Procedure

Participants were assigned to training augmentation condition based on the laboratory section in which they enrolled. For the first event (perioperative care), the students in one lab section were assigned to the VCE condition and the students in the other lab section were assigned to the MS condition. All participants completed training on that medical event. For the second event (DVT/Pulmonary Embolism), participants switched training augmentation conditions. Those initially in the VCE condition switched to the MS condition and those initially in the MS condition switched to the VCE condition. All students completed training on the second medical event. At the conclusion of each event all students completed an NCLEX-type multiple choice exam designed to assess knowledge and application skills for that event, and an attitude questionnaire designed to assess participants' satisfaction with the training augmentation they experienced. Following the completion of the second nursing event, participants completed a questionnaire comparing their attitudes and preferences for the two training augmentation conditions.

Results

Performance Assessment

The NCLEX-type multiple choice exam scores for participants under the two training procedures were compared in a within-subjects ANOVA. In this comparison, the participant's performance under the MS training augmentation condition was compared to his/her performance under the VCE condition. Based on prior research (4, 7), we hypothesized that performance using the MS would be significantly higher than performance under the VCE. As shown in Figure 1, however, participants attained significantly higher test scores under the VCE than MS training procedures, $F(1, 39) = 11.27$, $p < 0.01$.

We also compared the training effectiveness for each of the two medical events used in the training (Perioperative Care and DVT/ Pulmonary Embolism) as between-subjects analyses. The results are shown in Figures 2 and 3. For both medical events the mean test score was higher when the training procedure was VCE than when it was MS, but only the difference for the DVT/ Pulmonary Embolism Medical Event was significant, $F(1, 21) = 11.16$, $p < 0.01$. We conclude that participants benefited more from the VCE than the MS training, particularly when learning how to deal with a DVT/ Pulmonary Embolism Medical Event.

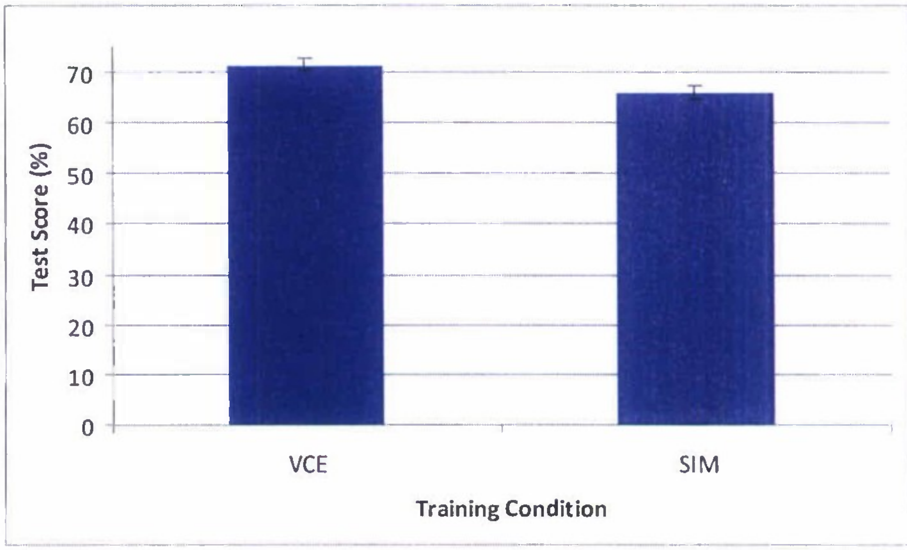

Figure 1. Mean Test Scores for Participants in the VCE and MS Training Conditions

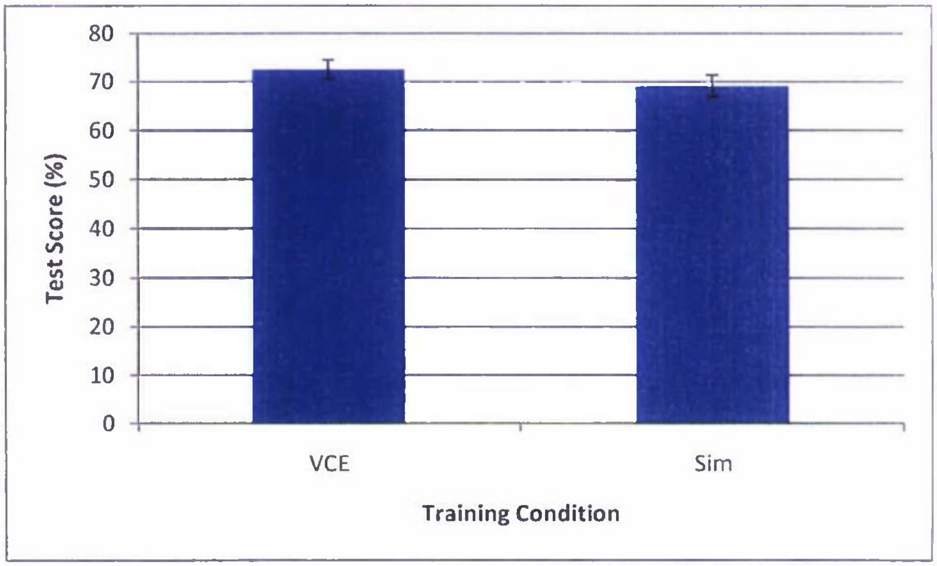

Figure 2. Mean Test Scores for Participants in the VCE and MS Training Conditions for the Perioperative Care Medical Event

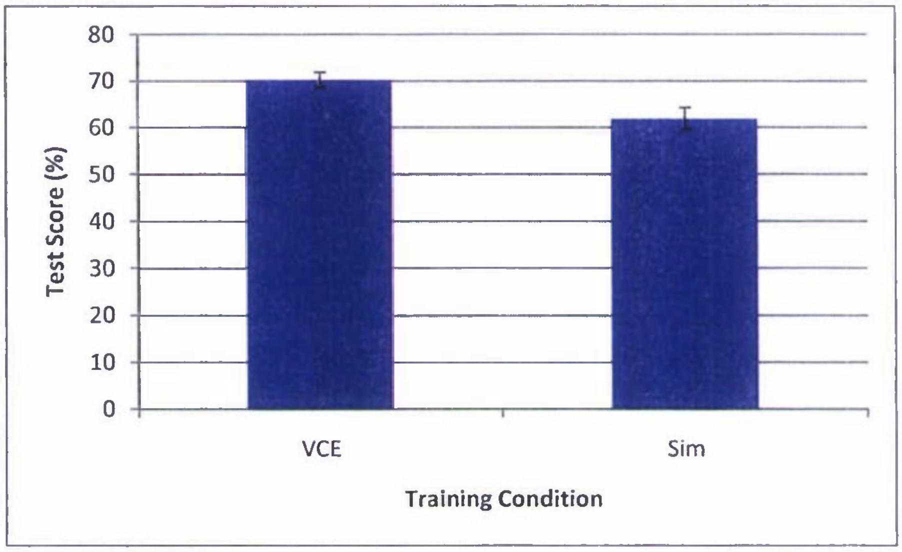

Figure 3. Mean Test Scores for Participants in the VCE and MS Training Conditions for the DVT/ Pulmonary Embolism Medical Event

Participants' Attitudes towards the Two Training Approaches

In the evaluation conducted at the end of each training session participants rated the training type received on a 7-point Likert-type scale on which 1 represented a poor rating and 7 an excellent rating. The mean rating score for VCE training condition (3.88) was not significantly different ($t < 1.0$) from the mean rating score for MS training condition (4.08).

The End of Study Questionnaire included five pairs of items comparing the two training approaches in terms of learning and application. Participants responded on a Likert-type rating scale ranging from 1 (low effectiveness/agreement) to 7 (high effectiveness/agreement). Table 1 shows the mean rating scores and standard deviations under each of the two training conditions for the five contrasts. The means on the first four contrasts were very close or identical, suggesting no preference for either type of training. Paired t-tests performed on the rating scores showed that only contrast 5 (patient evaluation) produced a significant result, $t(46) = 3.48$, $p < 0.01$. Participants felt that the MS training helped them better evaluate patients' vital signs than training with the VCE. This result was the only support for the hypothesis that students would prefer the MS training for the application of their clinical skills to patient care. The participants' preference for the MS training over the VCE training contrasts with the performance results, which were in favor of the VCE training

In addition to the items addressing specific aspects of the training, the End of Study Questionnaire also asked the participants which type of training they preferred overall. For this question, they responded on a 7-point scale with VCE at one end and MS at the other. Responses towards the lower or upper end of the scale would indicate a preference for the VCE or MS training, respectively. Responses in the middle of the scale indicate neutrality in terms of preference. The mean response was 4.36 (s.d. = 1.83), which is not significantly different from 4, the midpoint on the scale.

In fact, almost all of the ratings shown in Table 1 are not significantly different from the midpoint on the scale. The exceptions were the ratings for contrast I (extent to which it "felt like I was dealing with a real patient"), where both the VCE and MS ratings were significantly lower than 4 ($p < .006$ and $.p < 04$, respectively), and the VCE rating for contrast 5 (effectiveness of the software in helping you evaluate patient's vital signs), which was also significantly lower than 4 ($p<.001$). Taken as a whole, the ratings indicate that the participants were neutral about both training approaches without strong preference for the effectiveness/utility of either one.

Table 1. The Five Item Pairs From The End Of Experiment Questionnaire Contrasting Training Type

	VCE Item	MS ITEM	VCE mean/sd	MS mean/sd
Contrast 1	When I used the Virtual Clinical Excursion (VCE) software, it felt like I was dealing with a real patient	When I used the manikin simulation (MS), it felt like I was dealing with a real patient.	3.31/ 1.65	3.54/ 1.50
Contrast 2	I prefer to use the virtual excursion software (VCE) rather than the manikin simulation (MS) as a means to better apply information to a NCLEX-type exam.	I prefer to use the manikin simulation (MS) rather than the virtual excursion software (VCE) as a means to better apply information to a NCLEX-type exam.	4.00/ 1.76	3.83/ 1.63
Contrast 3	How effective was the virtual excursion software (VCE) in helping you to learn the course material?	How effective was the manikin simulation (MS) in helping you to learn the course material?	3.96/ 1.37	3.96/ 1.27
Contrast 4	How useful was the virtual excursion software (VCE) in helping you to apply what you learned in class to a simulated patient?	How useful was the manikin simulation (MS) activity in helping you to apply what you learned in class to a simulated patient?	3.74/ 1.51	4.11/ 1.32

Contrast 5	How effective was the virtual excursion software (VCE) in helping you evaluate a patient's vital signs?	How effective was the manikin simulation (MS) in helping you evaluate a patient's vital signs?	3.49/ 1.33	4.21/ 1.47

Discussion and Conclusions

Contrary to our hypothesis, the VCE training resulted in stronger performance on the knowledge test than the MS training. Results for stronger performance on the VCE training may relate to the student's ability to work independently and privately on the computer without distraction, thus enhancing concentration ability. Students performing the MS training were involved in actual simulated practice with an instructor present. Feelings of stress induced by this more public and perhaps implicitly evaluative situation could have affected the students' performance and concentration, and ultimately could have resulted in the lower testing outcome.

In general, nursing students indicate that they learn from 'doing 'and 'hands-on' practice. Thus, in terms of preference and perceived learning effectiveness of the training, our hypotheses that participants would prefer the MS received little support. Except for the evaluation of patients' vital signs, however, there were no significant differences between the MS and VCE ratings. Further, as indicated in Table 1, the mean ratings were close to the midpoint for both the MS and VCE training, indicating no strong preference (i.e., mean ratings in the 6-7 range) for either type of training. As the significantly lower than midpoint rating on simulator realism (contrast 1) suggest, neither the MS nor the VCE simulation gave the students the feeling that they were interacting with a real patient. Perhaps instructors need to give greater attention to the element of realism in simulated training, particularly when the focus is on complex clinical skills rather than individual nursing procedures, since even in the MS condition students did not feel that they were dealing with a real patient.

In light of the difference between the results of previous studies contrasting mannequin with virtual simulation (4, 7) and the present one, effectiveness of simulation for performance on multiple choice exams may need further study. Moreover, the significant difference in performance between the two training approaches for the DVT/Pulmonary Embolism medical event, but not the Perioperative Care medical event, suggests that additional events need to be studied in order to understand better the types of events for which the VCE is more effective.

Limitations

Because this study was conducted within the context of a course, it was not possible to randomly assign students to condition. Nor was it possible to randomize the order in which the two events were trained or to include a wider range of complex nursing events.

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Task 3) Deliverable: Evaluation report on the effectiveness of technology-delivered reinforcement methods following Diabetes Self-Management Education (DSME) programs

GOAL:

The goal of the study will be to examine the effects of standard methods of follow-up by Certified Diabetes Educators for patients with diabetes following DSME classes versus an innovative strategy utilizing technology-delivered, educational pop up messages via the Internet.

The Effectiveness of Reinforcement Methods Following Diabetes Self-Management Education

Abstract

There is considerable interest in the health care community in developing new strategies that are effective in enhancing the assimilation and retention of information necessary for patient self-management of diabetes. This pilot study evaluated the effectiveness of computerized follow-up methods compared to the standard telephone follow-up in adult patients with Type 2 diabetes who have participated in diabetes self management education (DSME) classes. In the computerized follow-up, participants accessed educational and motivational messages on a specially designed website approximately bimonthly over a nine-month period following the classes. Each message included informational tips about a particular topic relevant to diabetes control, and questions about the participant's activities relevant to that topic. We hypothesized that the computerized follow-up would result in improved knowledge, better behavioral (health-related) indicators, and greater satisfaction than the standard follow-up method, a telephone follow-up call three months after the classes.

Analysis of the data showed no support for our hypotheses. There was an increment in scores on the diabetes knowledge test from the start to the end of the study, but the improvement was significant only in the telephone group. There were no significant differences between the two groups in behavioral indicators, which included measures of A1C, cholesterol, and triglycerides. Satisfaction ratings were high in both groups, but not significantly different between the groups. Participants in the computer group reported no difficulty in accessing and using the website, or in understanding the information conveyed. They found the follow-up messages, especially those about medications, useful, but this did not result in improved behavioral (health) indicators across the period of the study. We conclude that the computer-based follow-up needs to be more interactive and more tailored to each participant's individual concerns and goals.

Introduction

There is considerable interest in the health care community in developing new strategies that are effective in enhancing the assimilation and retention of information necessary for patient self-management of diabetes. This pilot study compared the effectiveness of an experimental computerized follow-up method compared to the standard telephone follow-up method in adult patients with Type 2 diabetes who have participated in DSME classes and have computer internet access. The classes were conducted by a diabetes educator at the Conemaugh Diabetes Institute in Johnstown, PA. They addressed topics important to individuals with diabetes including what diabetes is, nutrition, stress management, managing hyper/hypoglycemia, monitoring blood sugar level, goal setting, and behavior change strategies. The computerized follow-up, which was accessed on the web, involved computer-generated educational messages, resource recommendations, and/or other learning tools focusing on the seven self-

care behaviors advocated by the American Diabetes Association (ADA) and the American Association of Diabetes Educators (AADE). Educational modules for the purpose of reinforcing the information presented in the DSME classes will be provided. The standard telephone follow-up is a call to the patient from a nurse (or CDE?) three months after the classes are completed.

Method

Sample:

Participation was solicited among adults who attended the diabetes education classes at Conemaugh Diabetes Institute. The requirements for participation were diagnosis of type II diabetes and access to a computer internet access. The sample included 8 males and 13 females. The age of the participants ranged from 37 to 85, with a mean age of 58. Of the 21 participants, one completed grade school, 11 completed high school, and 9 completed college. There were no significant differences between the telephone and computer groups in these variables.

Follow-up Intervention:

Control-group participants received standard follow-up by a CDE that consists of a telephone call three months after the classes ended to discuss their progress/problems and answer questions relating to goals established during DSME. Intervention-group participants were instructed to access a learning module at a website developed for this purpose on a weekly basis for three months following enrollment, then bi-monthly for the duration of the study. Computer-group participants received no telephone follow-up by a CDE.

Procedure:

Following enrollment, but prior to the conduct of the DSME classes, participants completed a background questionnaire and a diabetes knowledge test. A nurse collected clinical information, including weight, blood pressure, cholesterol, triglyceride, and A1C measures. The participants then attended the five (?) DSME classes, and met individually with a certified diabetes educator (CDE) to establish personal goals for better managing their condition (e.g., weight loss, exercise, diet). Following the classes, the participants in the computer-group started receiving weekly emails instructing them to access a learning module on the web. After a 3 month interval, a nurse collected A1C readings from all participants. At about this time, the participants in the telephone group were contacted by a nurse via telephone. After 3 months, the computer group participants received bi-weekly email reminders to access the website for the next learning module. At six months, a nurse collected clinical data including A1C, triglyceride, and cholesterol readings. At nine months, the end of the study, all participants completed a diabetes knowledge test and a satisfaction survey. A nurse collected A1C readings.

Results

We examined three factors: knowledge gain, behavioral (clinical) outcomes, and satisfaction with the program.

Knowledge gain:

Both the telephone and the computer groups received the educational classes, and there was a significant gain in pre- to post-knowledge scores. In examining the two groups separately, we found that the gain in the telephone group was statistically significant (t=4.61, df=7, p=.002), but the gain in the computer group was not (t=1.04, df=7, ns).

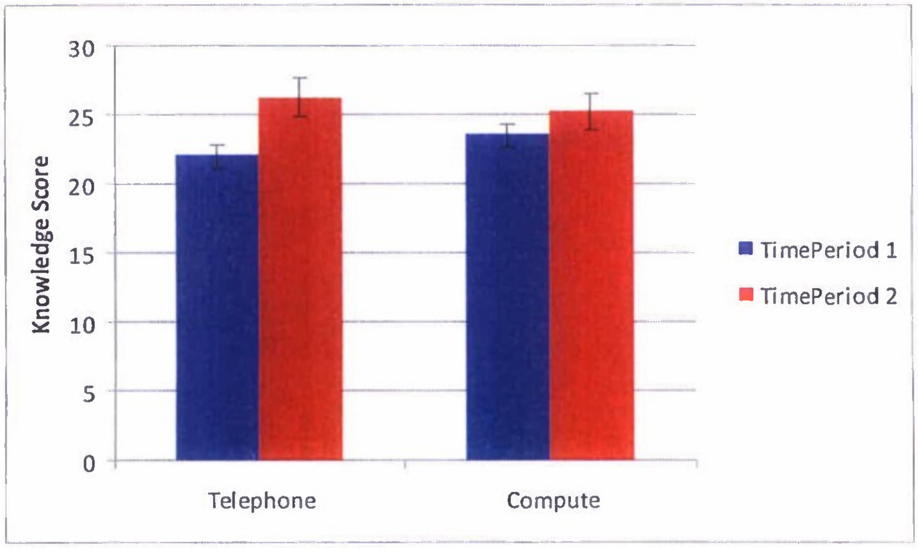

Figure 1. Pre- and post-study diabetes knowledge scores by experiment condition.

Clinical (behavioral) outcomes:

A1C was measures at four points: study outset, and at 3, 6, and 9 months. As shown in Figure 2, in both groups there was a significant (F(1,19) = 13.33, p=.002) drop in A1C levels during the first 3 months of the study, and then a slow (nonsignificant) rise. There was no statistically significant difference in scores between the two groups.

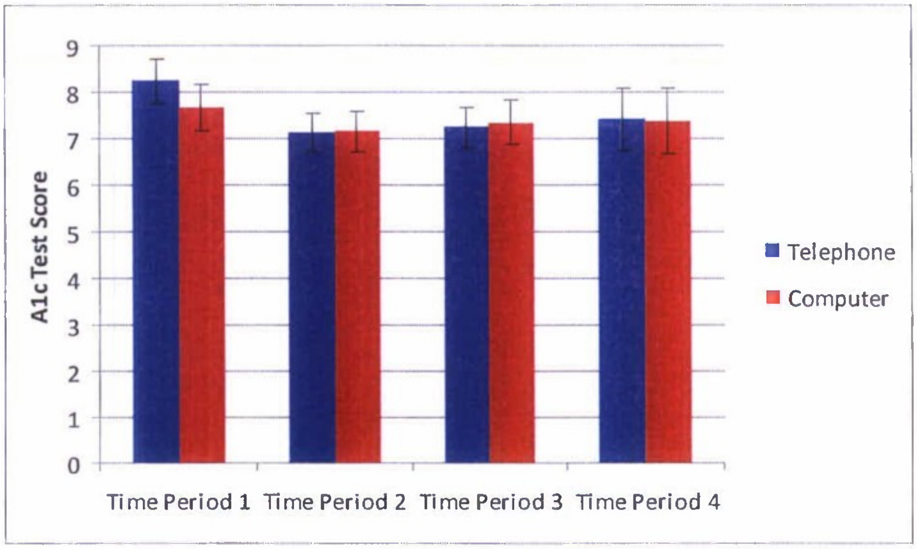

Figure 2. A1C levels

HDL and LDL cholesterol readings were taken at study outset an at the 6 month point in the study (see Figures 3 and 4). HDL went up significant in the computer group from study outset to six months ($t=2.85$, $df=9$, $p=.019$), but not in the telephone group. LDL fell slightly in the telephone group and, as HDL, rose significantly in computer group.

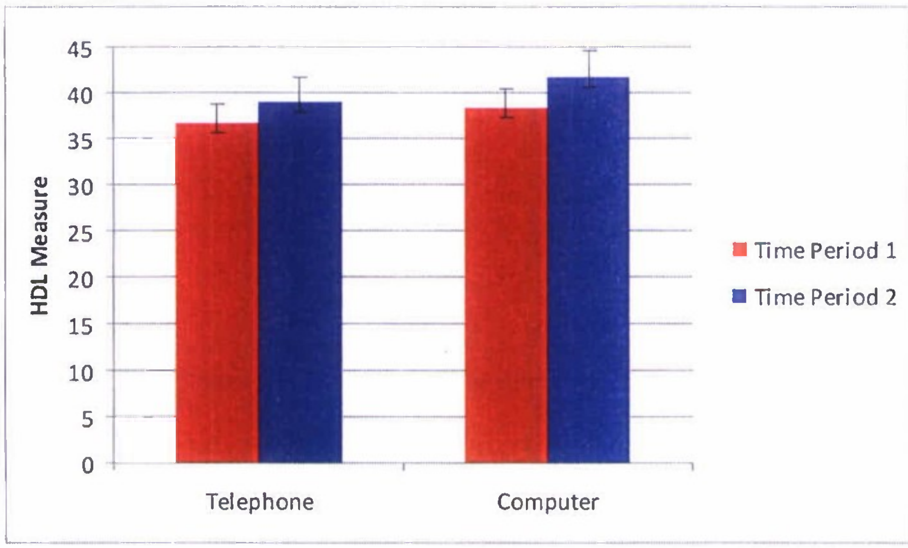

Figure 3. HDL scores at baseline and six months by experiment condition

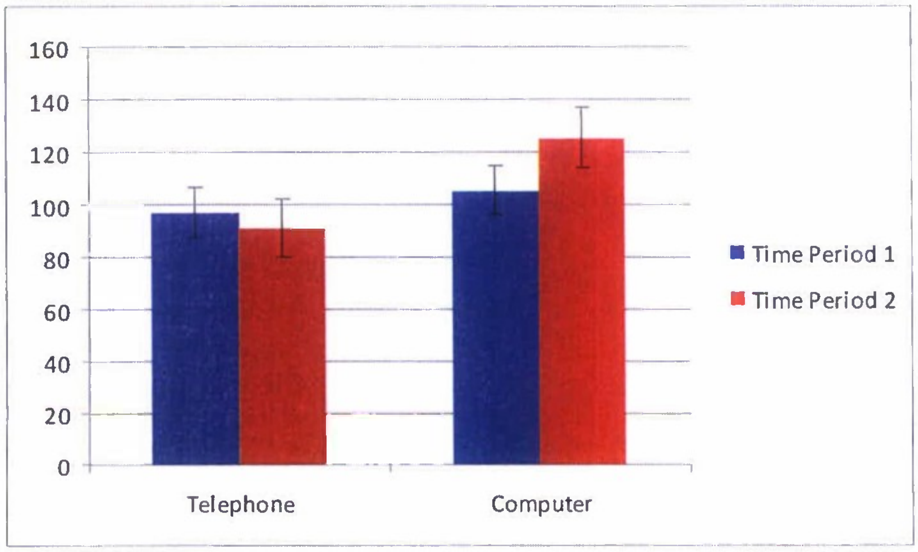

Figure 4. LDL scores at baseline and six months by experiment condition

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The triglyceride measures, which were taken at baseline and 6 months, are shown in Figure 5. The means in both groups dropped from baseline to six months, but insignificantly so. Although the computer group's measures are lower than those in the telephone group, the difference is not statistically significant.

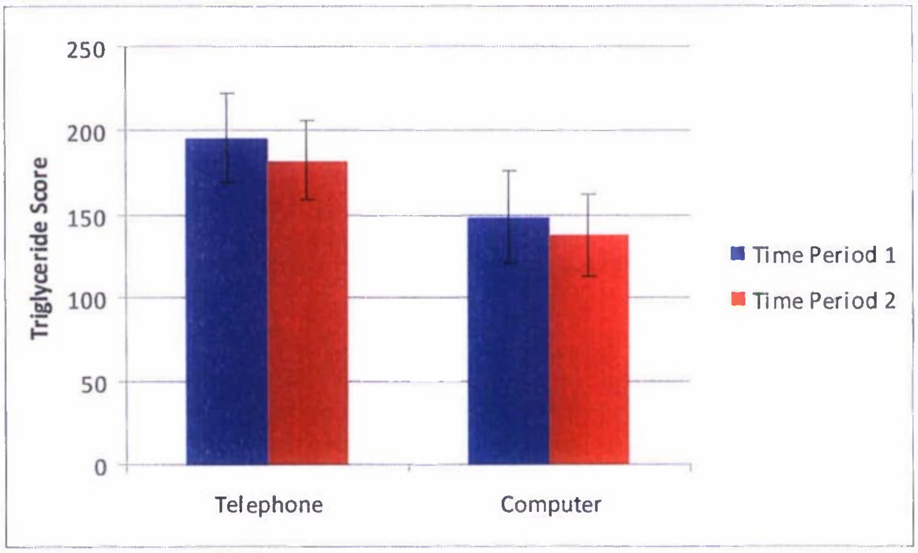


Figure 5. Triglyceride scores at baseline and six months by condition

Satisfaction:

The satisfaction questionnaire administered at the end of the study addressed the participants' satisfaction with the classes and the follow-up methodology, and their assessment of the value of the follow-up approach. Responses were made on a 7-point scale. On satisfaction items, the higher the response, the more positive the satisfaction.

Overall, as shown in Table 1, the responses to the program were above the midpoint rating in both groups. Only one of the 11 items addressing these factors showed a significant difference between the control and intervention group. Interestingly, it was an item asking how concerned they were about privacy issues when using a computer to communicate with a practitioner. Those who experienced the computer follow-up were significantly less concerned than those who received the telephone follow-up, suggesting the computer users were comfortable with that mode of communication. Although only this item yielded a significant difference, we noted that in the six questions addressing the convenience (Q5_3) , usefulness (Q7_5, Q9_6, Q10_7), and overall satisfaction (Q20_16, Q21_17) with the follow-up methodology, the mean rating was higher in the computer group than the telephone group in four of the items and approximately the same (within .1 points) in the other two, offering some suggestive evidence that those in the intervention group were more satisfied with the follow-up program than those in the control group.

	Condition	N	Mean	Std. Deviation	Std. Error Mean	
Q5_3: This method of diabetes follow-up was [very inconvenient/convenient]:	telephone	11	4.6364	2.41962	.72954	
	computer	9	6.0000	1.41421	.47140	
Q7_5: How useful were the messages for you?	telephone	10	5.1000	2.42441	.76667	
	computer	9	5.6667	1.80278	.60093	
Q9_6: To what extent did this method of follow-up help you to manage your diabetes	telephone	11	4.7273	2.57258	.77566	
	computer	9	4.6667	2.39792	.79931	
Q10_7: To what extent did this method of follow-up encourage you to meet the goals you established?	telephone	11	4.6364	2.50091	.75405	
	computer	9	5.0000	2.39792	.79931	
Q12a_8a: To what extent are you concerned about privacy issues when speaking to a practitioner on the phone?	telephone	10	4.5000	2.59272	.81989	high = not concerned
	computer	9	5.7778	1.39443	.46481	
Q12b_8b: To what extent are you concerned about privacy issues when using the computer for this purpose?	telephone	10	3.5000	2.59272	.81989	$t=2.53$, $p<.003$
	computer	9	6.0000	1.50000	.50000	
Q13a_9a: To what extent do you prefer to talk with a diabetes counselor to receive information	telephone	11	4.1818	2.67650	.80699	NOTE: this scale was not reversed; 1.e.
	computer	9	5.3333	.86603	.28868	
Q13b_9b: To what extent do you prefer to receive computer- generated messaging to	telephone	10	4.0000	2.26078	.71492	

receive information?	computer	9	5.0000	2.12132	.70711
Q14_10: At times during the follow-up program I felt the need to talk with a diabetes counselor	telephone	10	3.9000	2.07900	.65744
	computer	9	4.6667	1.73205	.57735
Q20_16: Overall, how satisfied were you with this method of education follow-up?	telephone	11	4.4545	2.58316	.77885
	computer	9	5.4444	2.29734	.76578
Q21_17: I would recommend this program to other persons with diabetes.	telephone	11	5.5455	1.75292	.52853
	computer	9	5.4444	2.55495	.85165

NOTE: this scale was not reversed; I.e.,

Table 1. Comparison of telephone and compute groups on comparable items on the Satisfaction Questionnaire [NOTE: Q numbers in column 1 of the table (e.g., Q5_3) refer to the question number on the computer and telephone group versions, respectively.]

Items on the satisfaction survey pertinent only in the computer group addressed the helpfulness of the email message reminding them to access the website, their difficulty in accessing the site and use of the site, and the ease of understanding the informational messages. Responses to these items were highly positive; the means ranged from 5.8 to 6.8, and the median and modal responses were 7 on all of them. We also asked the participants in the computer group how useful specific types of messages were for them (eating habits, exercise, medication, reducing risks, coping with problems). Messages about medication were perceived as most useful (mean=5.67, with no response below the midpoint (4). Messages about exercise and coping with problems were rated lower (both means = 4.78, with responses ranging from 1 to 7.

The satisfaction questionnaire included several open-ended questions asking participants about what they liked and what they disliked about aspects of the program, when they felt a need for person-to-person contact and in what ways the program helped them to manage their diabetes and meet the goals they had established at the outset. Responses to the open-ended questions were sparse, especially in the telephone group. In answering a question about how the class portion of the program could be improved, those in the telephone group who responded had no suggestions for improvement, saying it was informative, interesting, helpful, as is. Those in the computer group who responded were more likely to make suggestions for improvement including demonstrations of diabetes websites and on-line tools, more information about diet, and more on natural products to improve "sugar." In terms of what they liked and found helpful about the follow-up, those in the computer group mentioned the ease and convenience (not set schedule, could do from home) of the computer access, the helpfulness of the information (for example, about meal planning), and. the reminders about diet, exercise, and medication. Participants in the telephone group mentioned the friendliness and helpfulness of the person on the telephone, and the information provided. In terms of things they did not like about the follow-up or would change, computer group participants mentioned lack of personal contact, and the blandness or sameness of the information and questions. They suggested more content and quizzes to reinforce the information. Telephone group participants also mentioned the lack of personal contact, and the lack of helpful or additional information. They suggested more frequent phone calls and occasional in-person meetings.

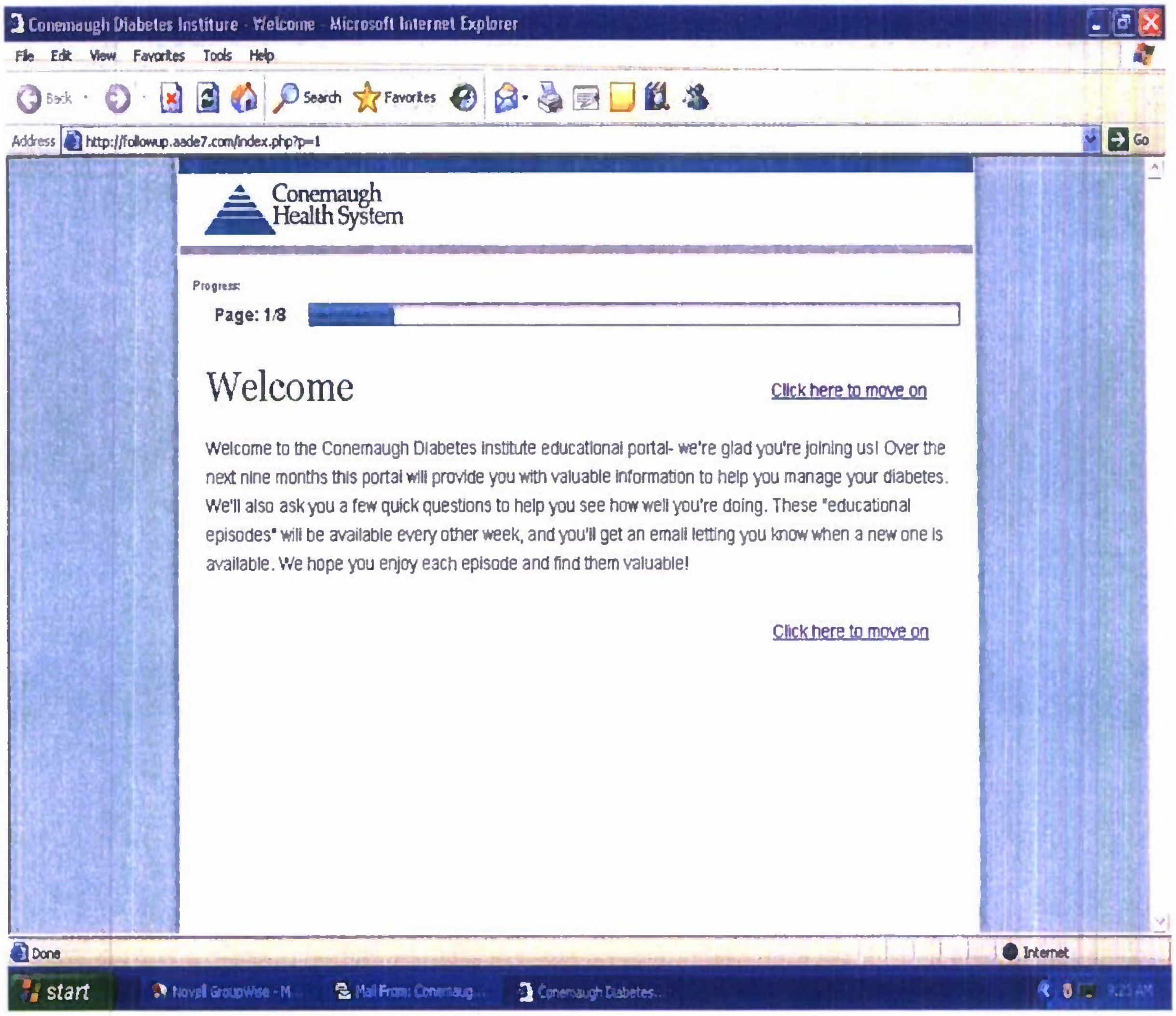
Discussion and Conclusions

This study was conducted over a nine-month time period. The results demonstrated an overall diabetes knowledge gain from baseline to the end of the study time period, but when the telephone and computer groups were looked at individually, only the telephone group's knowledge scores showed a statistically significant gain. There were no statistically significant differences between the groups in behavioral (clinical) measures. The A1C readings dropped significant in the first 3 months following the classes, suggesting that the educational classes may have had some impact on the participants' dietary behaviors, but there was no evidence that the follow-up messages enhanced the impact. Although the computer group's HDL went up significantly, it was accompanied by a significant increase in LDL. There were no significant differences between the two groups in participants' satisfaction ratings at the end of the study, but there was a tendency for the computer group's mean responses to items about the program to be equal to or higher than the telephone group's mean, providing a suggestion that those who received the computer group were more satisfied than those who received the telephone follow-up.

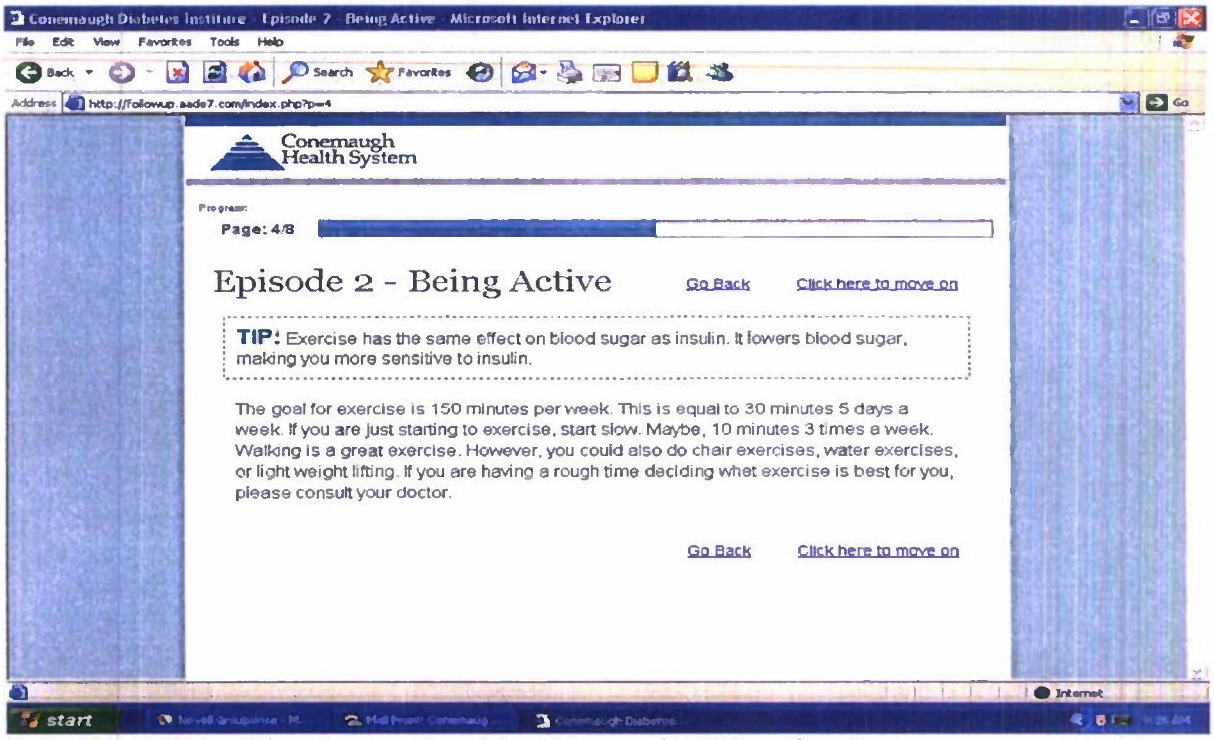
Although the satisfaction results gave a hint that those who received the computer intervention were more satisfied than those who received the telephone follow-up, there was no evidence that this higher level of satisfaction translated into stronger increases in knowledge or improvements in behavioral (clinical) measures. Nor, except for the short-term drop in A1C, did the increased knowledge in the telephone group result in improvements in behavioral measures. The participants n the computer group reported being comfortable with the computer medium, but the call for personal interaction suggests the need for a more interactive interface, and possibly one that is tailored to the individual's needs and concerns. For example, if the participant expressed greatest concern about exercise in a particular session, the computer messages would focus on exercise for that session, thereby making the user feel that the computer was responding to his or her concerns.

In the system that was implemented, the individual responded to questions at each follow-up session, but received no acknowledgement of or feedback about their responses. An interactive system may engage the participants more strongly. Data indicating that dieters who keep track of what they eat each day are more likely to lose weight [heard in presentation; need to find reference] than those who do not suggests that the computer interface should require people focused on diet to record what they had eaten. Similarly those focused on exercise, could record their specific exercise activities.

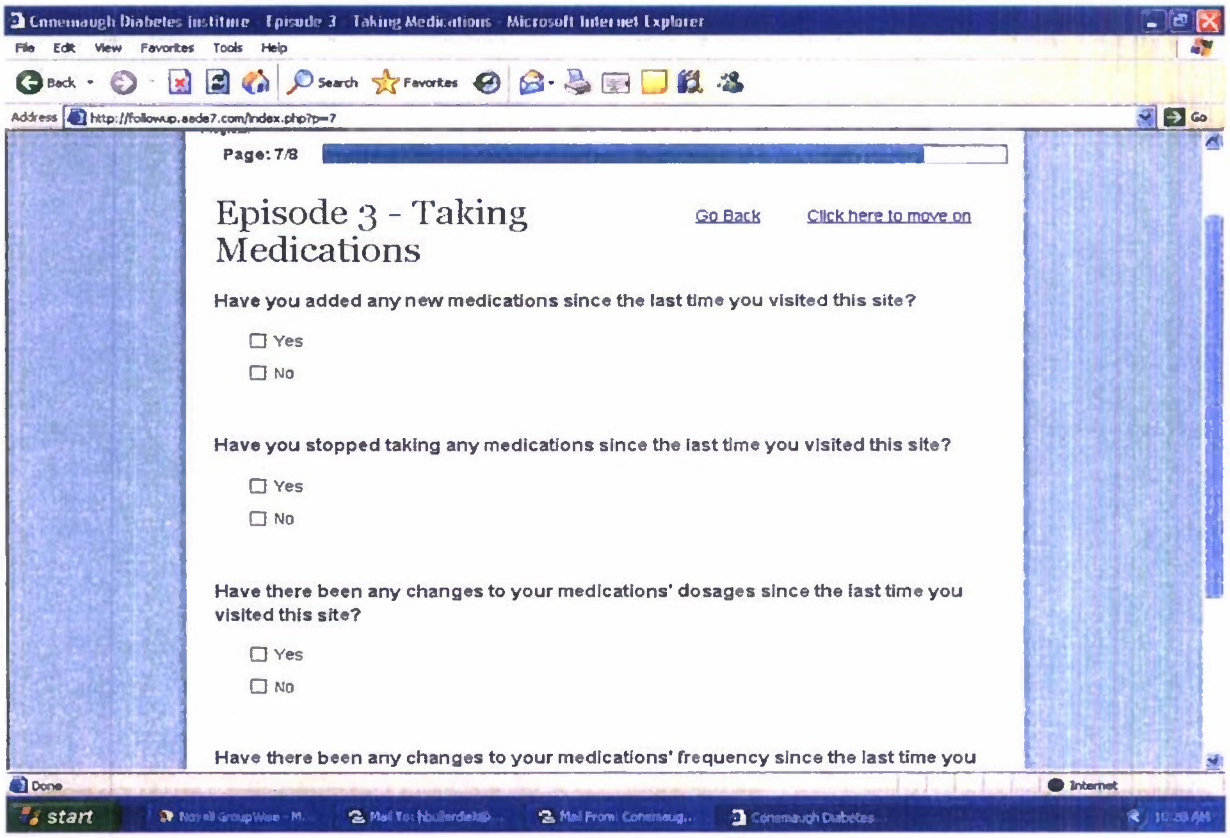
Glycemic control is a complex process involving dynamic management of diet, exercise, and medication and individuals with diabetes can experience considerable difficulty in applying the knowledge they have to their own (Klein et al., 2007). Reinforcement of knowledge gained in classes and follow-up support to apply this knowledge to an individual's day to day situations seems to require a more tailored and dynamically responsive process that, at least for a while, until habits are established and the knowledge has been applied in multiple situations, may need to be offered daily, rather than weekly or bimonthly.



Screen shot of the computer follow-up group email that the participant received bimonthly.



Screen shot of one of the educational modules(above) and questions (below) the computer group received.



DSME Follow-up Study

Episode Schedule for computer group

Episode 1 (Week 1)

Topic

Healthy Eating

Nutritional Tip: Milk and yogurt are good sources of calcium and protcin check the nutritional facts on the label

Educational Content

Read labels for serving size, servings per container, and total carbohydrates to determine the total amount of carbohydrates you will consume. Remember, 15 grams of carbohydrates equal "1 carb serving".

Questions

Episode 2 (Week 2)

Topic

Healthy Eating

Nutritional Tip: A one cup serving of broccoli is the size of a tennis ball.

Educational Content

Are you eating the proper portion sizes? If you are not sure, weigh and measure your food. Here are some serving size guidelines:

- Thumb = one tablespoon
- Deck of cards = 3 oz portion of meat or fish
- Tennis ball = 1 cup
- Using smaller plates will help you eat less.

Questions

Episode 3 (Week 3)

Topic

Healthy Eating

Nutritional Tip: Fresh and frozen vegetables have less added salt than canned vegetables. Drain and rinse the vegetables if you want to remove the salt.

Educational Content

Don't forget to eat your fruits and vegetables. The ADA Food Pyramid Guide recommends 5 to 9 servings of fruits and vegetables daily. The more color in your selection of fruits and vegetables, the more nutrients you will get from the food.

Questions

Episode 4 (Week 4)

Topic

Healthy Eating

Nutritional Tip: One serving of alcohol is approximately 80-150 calories, one 16 ounce chocolate milkshake at McDonalds has 580 calories and 102 grams of carbohydrate, one Minute Maid apple juice box has 90 calories and 23 carbs, One 16 ounce coke has 150 calories and 40 carbs, one small diet coke has NO calories and NO carbs

Educational Content

Some drinks, especially alcohol, contain carbohydrates and need to be worked into your meal plan. Water is the cheapest drink and is healthy for you. Generally, each person should drink between 6 to 8 glasses of liquid daily, preferably water.

Questions

Episode 5 (Week 6)

Topic

Healthy Eating

Nutritional Tip: All fats are high in calories, limit serving sizes for good nutrition and health.

Educational Content

For each gram of fat you eat you get twice the calories as you do from protein or carbohydrates. One gram of protein equals 4 calories; one gram of carbohydrate equals 4 calories; one gram of fat equals 9 calories.

Questions

Episode 6 (Week 8)

Topic

Healthy Eating

Nutritional Tip: Dietary fats are a part of a healthy diet, the type of fat eaten is important for heart health. Choose most of your fats from plant sources like nuts, seeds, vegetable oils and avocados.

Educational Content

A fat is a fat is a fat – when calories are concerned! As a general rule, saturated fat is hard at room temperature and raises cholesterol levels. Mono-unsaturated fat is liquid and does not raise cholesterol levels. Mono-unsaturated fats are better for your heart. Choose oils such as olive and canola when cooking.

Questions

Episode 7 (Week 10)

Topic

Healthy Eating

Nutritional Tip: Eating at least three meals a day helps you balance the amount of carbohydrate you eat throughout the day to manage your blood glucose. Skipping meals can lead to hypoglycemia (low blood glucose), especially if you take insulin.

Educational Content

It is important not to skip any meals, eat your meals on a regular basis, and sometimes snacks are needed throughout the day and evening. You should eat something every 4 to 5 hours. By doing this, you should have better control of your blood sugar levels. Keep in mind that what you eat throughout the day should not go over the total carbs you are allowed.

Questions

Episode 8 (Week 12)

Topic

Healthy Eating

Nutritional Tip: Dietary Recommendations are that

55-60% of total calories should come from carbohydrates

10-20% of total calories should come from protein

Less than 30% should come from fat

Educational Content

When you sit down for a meal, draw an imaginary line through the center of your plate. Draw a line to divide one section into two.

- About one-fourth of your plate should be filled with grains or starchy foods such as rice, pasta, potatoes, corn, or peas.
- Another fourth should be protein – foods like meat, fish, poultry, or tofu.
- For the last half of your plate, fill with non-starchy vegetables like broccoli, carrots, cucumbers, salad, tomatoes, and cauliflower.
- Add a glass of non-fat milk.
- Finally, add a small roll or piece of fruit.

Questions

Episode 9 (Week 14)

Topic

Being Active

Exercise Tip: Exercise has the same effect on blood sugar as insulin. It lowers blood sugar, making you more sensitive to insulin.

Educational Content

The goal for exercise is 150 minutes per week. This is equal to 30 minutes 5 days a week. If you are just starting to exercise, start slow. Maybe, 10 minutes 3 times a week. Walking is a great exercise. However, you could also do chair exercises, water exercises, or light weight lifting. If you are having a rough time deciding what exercise is best for you, please consult your doctor.

Questions

Episode 10 (Week 16)

Topic

Being Active

Exercise Tip: A person weighing 140 pounds would burn 6.4 calories/minute cycling, 8.6 calories/minute dancing, 9 calories /minute swimming, and 7.6 calories/minute walking

Educational Content

Did you take a walk today? Did you get on your bike or treadmill today? Did you do some form of exercise today? Regular exercise will help you to better control your blood sugar numbers, reduce stress, and make you feel better.

Questions

Episode 11 (Week 18)

Topic

Being Active

Exercise Tip: Any exercise is better than no activity so add more daily activity.

Educational Content

How active have you been today?

- Did you take the stairs instead of the elevators?
- Did you park further away from the entrance to the store?
- Did you stand and walk in place during the commercial break?
- Did you lift light weights during the commercial break?
- Did you pace the kitchen while talking on the phone?

Questions

Episode 12 (Week 20)

Topic

Being Active

Exercise Tip: To maintain your exercise program find a buddy, do something you enjoy, join an exercise class, walk your dog.

Educational Content

Exercising on a regular basis can help:

- relieve stress
- you sleep better
- increase your energy
- decrease your blood pressure
- decrease your **L**DL (**l**ousy or bad which you want **l**ow) cholesterol
- increase your **H**DL (**h**ealthy or good which you want **h**igh) cholesterol
- strengthen bones
- promote regularity
- improve strength, balance, and flexibility.

Questions

Episode 13 (Week 22)

Topic

Monitoring

Monitoring Tip: Research has shown that keeping your blood glucose as close to normal as possible, can prevent or slow the complications of diabetes.

Educational Content

Check your blood sugar on a regular basis using different times of the day. Your blood sugar target range should be between 80 and 130. If you are consistently running above those numbers, consult your physician. If you stay within the target range, it has been shown that you may delay or prevent the onset of complications.

Questions

Episode 14 (Week 24)

Topic

Taking Medications

Medication Tip: ALWAYS carry a list of your medications and their doses with you. The list should include your prescription meds, vitamins, over the counter meds and herbal supplements.

Also include your medication allergies.

Educational Content

Make sure to take your oral medications as prescribed by your physician, including taking them at the same time every day. Short acting and intermediate acting insulin, for best results, should be taken 30 minutes before you eat your meal. Fast acting insulin (including inhaled insulin) should be taken approximately 10 to 15 minutes before you eat.

Questions

Episode 15 (Week 26)

Topic

Problem Solving

Sick Day Tip: When you are sick, your body will release hormones that work to help your body fight against your illness, but they will also make your blood sugar rise.

Educational Content

When you are sick:

- take your diabetes medication or insulin
- check your blood sugar every 2 to 4 hours
- drink 8 ounces of water or sugar free liquids every hour
- eat 10 to 15 grams of carbohydrates every 1 to 2 hours

- rest.

Questions

Episode 16 (Week 28)

Topic

Healthy Coping.

Coping Tip: Millions of people have diabetes. Although diabetes is a serious health problem, with proper care you can learn to manage your diabetes and lead a full and active life.

Educational Content

Diabetes is a life long disease, it does not go away. You can live a healthy, productive life. Support may be found from friends, relatives, and health care providers. Many celebrities live with diabetes including: Mary Tyler Moore, Patti LaBelle, and B. B. King. You can even climb to the top of Mount Everest as Will Cross (diagnosed with Type 1 diabetes) did in 2005.

Questions

Episode 17 (Week 30)

Topic

Reducing Risks

Foot Care Tips: High blood glucose levels increase the risk of skin and foot infections.

Never go barefoot, wear comfortable shoes and socks that fit well, file your toenails straight across with an emery board, call your health care provider if you injure your feet in any way and use skin lotion on the outside of your feet to help prevent dryness.

Educational Content

Inspect your feet daily or at least one to two times per week. It is important to watch for small cuts, sores, bruises, etc. before they develop into a larger problem. Most amputations can be prevented if problems are caught early and treated.

Questions

Episode 18 (Week 32)

Topic

Reducing Risks

Risk Reduction Tip: Diabetes can cause damage to the blood vessels that supply blood to the retina. Retinopathy can lead to blindness.

Educational Content

Have you had your yearly eye exam? If not, make an appointment to have one done. It is important for detecting and/or preventing eye disease. Retinopathy (damage to the retina of the eye) is one of the complications of diabetes and can only be detected by a dilated eye exam. Call your healthcare provider right away if you notice any changes in your sight such as: blurry vision or specks floating before your eyes

Questions

Episode 19 (Week 34)

Topic

Reducing Risks

Risk Reduction Tip: Heart disease and stroke are much more likely to occur in people with diabetes. Eating foods high in saturated fat, trans fat, and cholesterol can lead to excess lipids (such as cholesterol and triglycerides) in your blood. Over time lipids can damage your blood vessels causing circulatory problems.

Educational Content

ADA recommends a yearly lipid profile. This includes total cholesterol, triglycerides, LDL, and HDL. You should "know your numbers". Total cholesterol should be less than 200; triglycerides less than 150; LDL less than 100; and HDL greater than 40 for men and greater than 50 for women.

Questions

Episode 20 (Week 36)

Topic

Reducing Risks

Risk Reduction Tip: The A1C test measures your average blood glucose level over the past 2 or 3 months. The results of this test, which is done by your health care provider, combined with your own blood glucose testing will help assess your risk of diabetes complications

Educational Content

ADA recommends an A1C blood test at least twice a year. You should "know your number" and it should be less than 7.0

Questions

<u>Episode 21 (Week 38)</u>

<u>Topic</u>

Reducing Risks

Risk Reduction Tip: Cigarette smoking is the most important modifiable cause of premature death for those with and without diabetes. Smoking is also related to the earlier development of microvascular complications

<u>Educational Content</u>

Do you smoke? If you do, you should consider stopping. Smoking puts people with diabetes at greater risk for developing cardio-vascular complications which include heart attacks and strokes. Contact your local health care facility to see if they have smoking cessation classes.

<u>Questions</u>

DSME follow-up, clinical, and medication data questions

One or more of the following questions may be asked to the patient during the course of an episode.

Have you added any new medications since the last time you visited this site?

- Yes
- No

Have you stopped taking any medications since the last time you visited this site?

- Yes
- No

Have there been any changes to your medications' dosages since the last time you visited this site?

- Yes
- No

Have there been any changes to your medications' frequency since the last time you visited this site?

- Yes
- No

How well have you been following your meal plan?

- Not at all
- Occasionally
- Most of the time

How often are you testing your blood sugar?

- Once a day
- Twice a day
- Other

What are your average blood sugar results over the last month? Most of the time:

- Under 140
- Between 140 - 160
- Between 160 - 200
- Over 200

Do you exercise on a regular exercise?

- Yes
- No

How often do you see your family physician?

- More than once a year
- Once a year
- Only when I'm sick (less than once a year)
- Never

When was your last appointment with your family physician?

- Last 6 months
- Last year
- Over a year ago
- Never
- Don't know

When is your next scheduled appointment with your family physician?

- In the next 6 months
- In the next year
- I don't have one scheduled

When was your last dilated eye exam?

- Last 6 months Good job; you need to maintain good eye health.
- Last year Good job; you need to maintain good eye health.
- Over a year ago Yearly eye exams are recommended; protect your eye health.
- Never Diabetes puts you at higher risk for eye complications.
- Don't know If you can't remember; you're probably past due for an eye exam.

Have you had an A1C test since the last time you visited this site.

- Yes
- No

What was the result of your last A1C test?

- [nnn]

Have you had your urine checked for protein since the last time you visited this site.

- Yes
- No

What was the result of your last urine check for protein?

- Normal
- Abnormal
- Don't know

Have you had your cholesterol checked since the last time you visited this site.

- Yes
- No

What was the result of your last cholesterol check?

- Total: [nnn]
- HDL: [nnn]
- LDL: [nnn]

During your educational session you chose the following behavior goal:

[GOAL]

How well have you been meeting this goal:

- Never It may be helpful to review the written material from your diabetes classes
- Rarely Try to identify what's keeping you from meeting your goal.
- Sometimes It's a work in progress; don't give up.
- Mostly You're headed in the right direction; keep going
- Always Wonderful! Keep up the good work.

PRODUCTIVITY FOR AWARD NUMBER N00014-04-1-0825

Refereed Articles * = Data Based

Grady, J.L., & Hobbins, B. (2009). How can state boards of nursing encourage curricular reform? [Headlines from the NLN]. Nursing Education Perspectives, 30(1), 59-61.

*Neuman, L.H., Pardue, K.T., **Grady, J.L.**, Gray, M.T., Hobbins, B., Edelstein, J. (2009). What does an innovative teaching assignment strategy mean to nursing students? *Nursing Education Perspectives.* 30(3), 159-163.

Workshops and Conferences:

Published Abstracts

Winters, J. & **Grady, J.L.**, (2009). Using telehealth technologies for teaching remote assessment to undergraduate nursing students [Abstract]. *Telemedicine and e-Health,* 15, supplement 1, 63.

INVITED:

2010

Videoconferencing for Clinical Learning and Technology Tools to Enhance Clinical Learning (2 sessions). Emerging Technologies in Nurse Education Conference - Sponsored by Contemporary Forums. Boston, MA. (Conference scheduled for July 19-20, 2010).

2009

Developing a Virtual Classroom . ELITE Faculty Development Workshop. University of Pittsburgh School of Nursing, Pittsburgh PA.

Learning by Simulation: State of the Science? (Keynote) Indiana University of Pennsylvania Department of Nursing and Allied Health, Simulation Conference, Indiana PA.

PEER REVIEWED PRESENTATIONS

2010

Reaching Out to Rural Elders: Evaluating Telehealth with a Human Touch in Assisted Living Facilities. American Telemedicine Association 15th Annual International Meeting and Exposition. San Antonio, TX. (Conference scheduled for May 16-18, 2010).

Do You Wiki? Using a Wikispace for Collaborative Scholarly Work. National League for Nursing Education Summit 2010. Las Vegas, NV. (Co-present with members of Curriculum Innovation Task Group) – (Conference scheduled for Sept 29-Oct 2, 2010).

2009

Targeting Diabetes in Adolescence: Evaluation of an e-Health Approach to School-Based Care. 12th Annual Conference of the Canadian Society of Telehealth. Vancouver, BC, Canada.

Introducing Baccalaureate Students to Telehealth Nursing. 12th Annual Conference of the Canadian Society of Telehealth. Vancouver, BC, Canada. Co-presenter Jill Winters, PhD, RN.

Introducing Baccaluareate Students to Telehealth Nursing. American Association of Colleges of Nursing 2009 Baccalaureate Education Conference. Chicago, IL. Co-presenter Jill Winters, PhD, RN.

APPOINTMENTS/HONORS

2010 Received award for "Outstanding Contributions to Telehealth Nursing," Presented annually by the Telehealth Nursing Special Interest Group of the American Telemedicine Association.

Appointed member, Academy of Nursing Education Review Panel, 2009-10.

Named to Pennsylvania Business Central "Top 100 People of 2009"

2009 Innovative Use of Store and Forward Technology Award, Canadian Society of Telehealth

Appointed member, Academy of Nursing Education Review Panel, 2008-09.

Peer review panel, *Nursing Education Perspectives*

Selected as reviewer, National League for Nursing (NLN) Nursing Education Research Grant Program, 2009 cycle.

Peer reviewer for American Telemedicine Association (ATA)14th Annual International Meeting and Trade Show. Las Vegas, NV.